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UNITED STATES DEPARTMENT OF AGRICULTURE

BULLETIN No. 354

Contribution from the Forest Service,
HENRY S. GRAVES, Forester

Washington, D. C. ▼ October 20, 1916

FORESTS OF PORTO RICO; PAST, PRESENT, AND FUTURE, AND THEIR PHYSICAL AND ECONOMIC ENVIRONMENT.

By Louis S. Murphy, *Forest Examiner.*

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INTRODUCTION.

Every year the people of Porto Rico consume over three times as much wood as the forests of the island produce. Great quantities of timber have been cut or burned by the "conuco" to make a clearing, which is abandoned after a few years and becomes a mere waste. The charcoal burner is still at work destroying the young growth needed to keep up the forest. Failure to put an end to the destructive practices that are rapidly reducing the forests or to provide the means of developing and fully utilizing them in a scientific manner has already brought about a shortage in the domestic supply of wood and consequent hardship to the people. It is the object of this bulletin[1] to give a complete account of the trees and the forests of Porto

[1] Under an informal cooperative arrangement between the Secretary of the U. S. Department of Agriculture and the Governor and Board of Commissioners of Agriculture of Porto Rico the author spent six months, from November, 1911, to May, 1912, on the island, making a first-hand study of its forest problems. A preliminary report of his findings and recommendations regarding these problems was published in the "First Report of the Board of Commissioners of Agriculture of Porto Rico," San Juan, Jan. 1, 1912, pp. 48–60. In this report it was recommended that the authority of the board be extended to cover the management of the forests; and that an insular forest service, with a qualified and experienced forester in charge, be established to carry on the work. This service could be established at a maximum cost of $20,000 and maintained for $8,000 or less a year, and would effect an annual gain to the island through the scientific management of its forests amounting to over $350,000.

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Rico, to show their value to the people of the island, and to suggest the means of improving them and making them permanent.[1]

PHYSICAL AND ECONOMIC FEATURES.

Porto Rico is very sparsely wooded. The impenetrable forest jungles, commonly associated with the West Indies, are so scarce that one may cross and recross the island without seeing them, for, with the exception of those in the Sierra de Luquillo, they are tucked away in the more inaccessible places into which few except the "jibaro" ever penetrate. The island is, however, by no means devoid of wood growth. Around almost every habitation there are groups of trees, such as the bread fruit and mango; and numerous scattered single trees, mostly palms, dot the open landscape. The protective cover of shade trees of the coffee plantations gives a decidedly forested appearance to many localities.

Porto Rico presents an unusual combination of physical and economic conditions. The insular and geographic position of the country, its diminutive size, its restricted area of level lands, and its density of population, to mention but a few of many influences, have occasioned unusual demands on the forests. The same cycle of change is found here as is recorded by civilization everywhere—a profligate waste and despoliation of the bounties of nature, followed by an acute need for what has been destroyed.

GEOGRAPHIC SITUATION.

Porto Rico is the easternmost and smallest of the Greater Antilles and is well within the Tropics. It is situated between latitudes 17° 54′ and 18° 30′ north and longitude 65° 35′ and 67° 15′ west, occupying a position about midway in the chain of islands connecting Florida and Venezuela and separating the Carribean Sea from the Atlantic Ocean. It is about 450 miles east and slightly south of the nearest point of Cuba; about 500 miles north of the nearest point of Venezuela; about 1,000 miles from Colon (Panama); about 1,500 miles from New York and New Orleans, and a little more than twice that distance from Gibraltar.

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[1] In addition to new material the present bulletin revises and brings up to date two previous bulletins of the Forest Service: "Notes on the Forest Conditions of Porto Rico," by Robert T. Hill, Bulletin 25, Division of Forestry, Department of Agriculture, 1899, and "The Luquillo Forest Reserve, Porto Rico," by John C. Gifford, Bulletin 54, Bureau of Forestry, U. S. Dept. of Agriculture, 1905.

It is appropriate to acknowledge in this place the author's indebtedness to the works enumerated above and in the bibliography. Special acknowledgment is due to the officers and employees of the Insular Government and of the Porto Rico Agricultural Experiment Station (U. S. Dept. of Agriculture) for giving the author access to official unpublished data and personal assistance in locating and getting to the various places visited; to Mr. Paul Buffault, Conservateur, Administration des Eaux et Forets, France, and Mr. Thomas R. Wallace, American consul at Fort de France, for valuable information concerning forest conditions and legislation in Martinique (French West Indies); also to the Office of Acclimatization and Adaption of Crop Plants of the Bureau of Plant Industry, Department of Agriculture, for the use of photographs comprising Plates I, IV, and VI, fig. 1.

Porto Rico has a total area of 3,435 square miles (2,198,400 acres).[1] The main island is 3,349 square miles in extent, and the islands of Vieques, Mona, Culebra, and other adjacent smaller islands within its governmental jurisdiction are 51.5, 19.5, 11, and 4 square miles, respectively. The territory as a whole is thus about five-sixths the size of Jamaica or the island of Hawaii, seven-tenths the size of Connecticut, and four times as large as Long Island.

In general outline it is almost a geometrically regular parallelogram, approximately 100 miles long and 35 miles wide. Its longest dimension lies east and west. The sea line is nearly straight and the coast is usually low, especially on the southern side, although there are a few headlands. The only protected harbors are San Juan on the north coast, Guanica and Jobos on the south, and Ensenada Honda on the southeast. The remaining ports, such as Arecibo, Mayaguez, and Ponce, are scarcely more than open roadsteads.

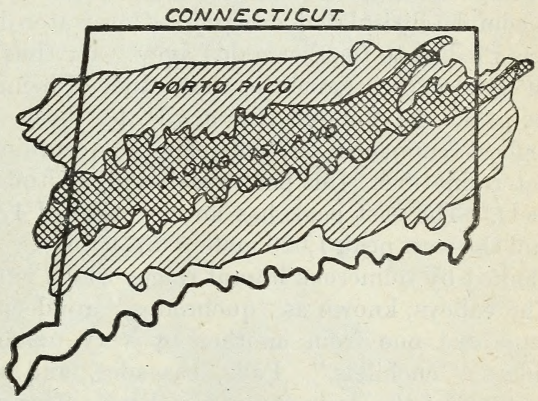


FIG. 1.—Porto Rico compared in size with Connecticut and Long Island, New York.

PHYSIOGRAPHY AND SOILS.

Porto Rico and the other islands of the Antilles and Central America and northern South America were formerly, according to geologists, a united and distinct continental land mass—the Antillean continent. Then came a great subsidence, which left only the tops of the mountains above water. After a while the ocean floor was again thrust up, the old continent reappearing. The sediment of which it was composed, covered in the meantime by deep-sea muds and chalks, was then folded into huge mountain systems, individual peaks reaching as high as 20,000 feet above sea level. Another but lesser subsidence of the Antillean continent accomplished its breaking up into the present island groups, Jamaica being the first to be isolated, then Cuba, and finally Porto Rico and Haiti.

There are at the present time three main physiographic regions of the island of Porto Rico—a central mountainous core of volcanic

[1] "Areas of the United States, the States and Territories," Bulletin 302, U. S. Geological Survey. This area is the one officially determined upon by the U. S. Geological Survey, the General Land Office, and the Bureau of the Census, and is based on computation from the U. S. Coast Survey map. The detailed figures concerning the areas of the smaller islands were obtained directly from the Office of the U. S. Coast and Geodetic Survey.

origin, an elevated area of coral limestone (former marginal marine deposits) surrounding the mountainous portion, and the coastal plain.

CENTRAL MOUNTAIN AREA.

The central mountain area occupies by far the largest portion of the island. Viewed from the sea it presents a rugged and serrated aspect; numerous peaks and summits, with no definite crest line, rise from a general mass, which has been cut by erosion into lateral ridges, separated by deep, steep-sided gorges. The drainage divide is approximately parallel to the southern coast and about 10 or 15 miles distant from it. The region thus has a long and relatively gentle inclination toward the north coast, but falls off rather abruptly toward the south.

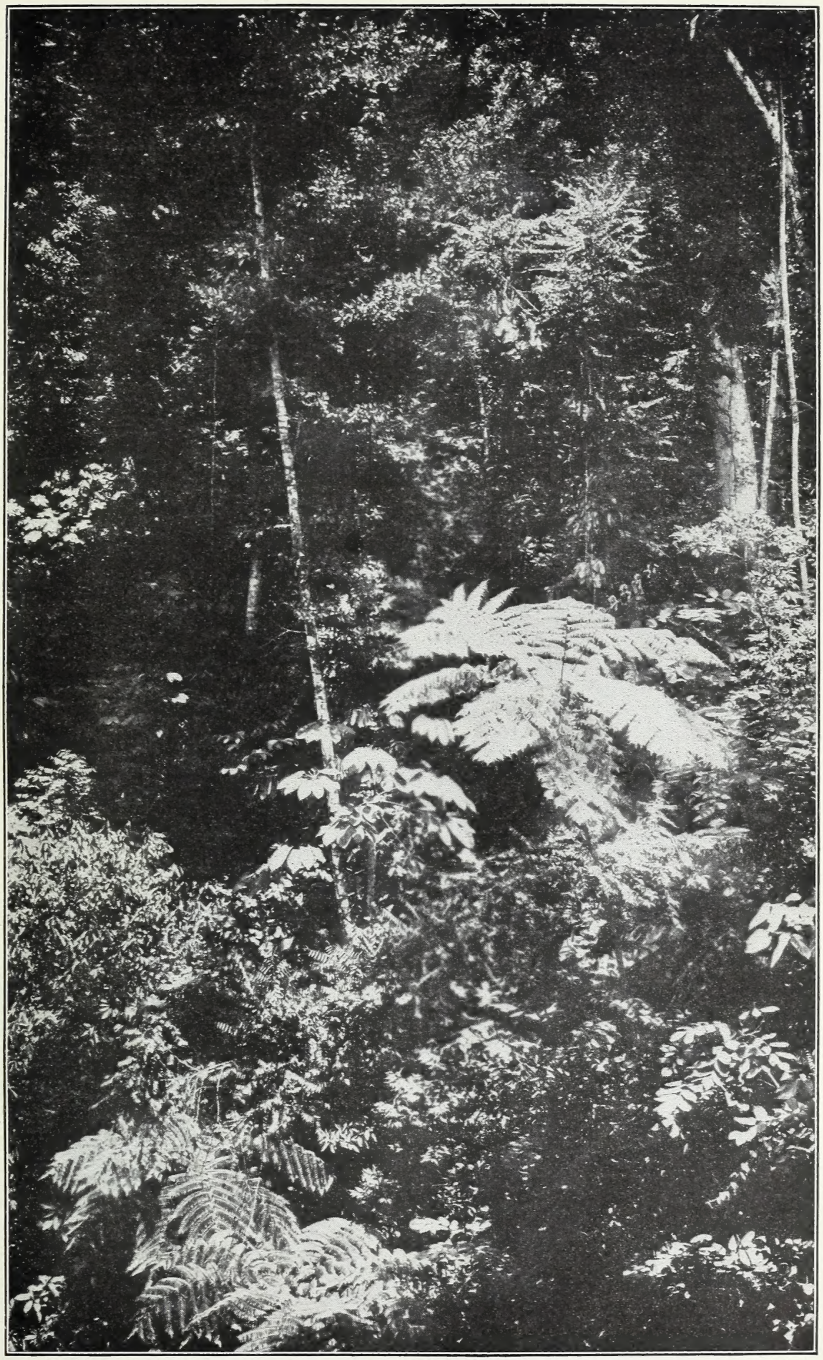
The Sierra de Luquillo,[1] the most easterly of the three ranges making up the central mountain mass, is surrounded by low coastal plains, and is completely isolated, except for a low water-divide which crosses near Las Piedras to the Sierra de Cayey. By thus completely dominating the landscape it gains the appearance of being very high; and one of its peaks, El Yunque (the anvil), has been credited with being the highest eminence on the island. According to the most recent determinations [2] this peak reaches an altitude of 1,062 meters (3,483 feet). The east peak has an elevation of 1,054 meters (3,457 feet) and the west peak 1,020 meters (3,346 feet).[3] These higher peaks are flanked by numerous lateral ridges which extend in every direction. The valleys, known as "quebrados," are deep and gorgelike and are separated one from another by very narrow, almost knife-edged ridges, "cuchillas." Falls, cascades, and rapids are conspicuous features of the drainage system here. This range supports the only large tract of virgin forest growth on the island.

The remaining mountain mass forms an uninterrupted expanse of broken uplands. The main crest line extends from Humacao on the east through Aibonito and Adjuntas to within a short distance of Mayaguez on the west coast. The portion east of Aibonito is known as the "Sierra de Cayey;" that to the west, the "Cordillera Central." This region has an average elevation of about 2,500 feet, above which the higher peaks project irregularly, a few to an elevation of more than 3,500 feet. The thirteen highest peaks on the island are in the "Cordillera Central." The highest of these (not named on the Coast and Geodetic Survey chart) situated about due south of Jayuya, has an

[1] Herrera (see Bibliography) describes the Luquillo as follows: "Ten leagues East-South-East from the City of Puerto Rico is a very high and great Mountain, with three Breaks on it, call'd del Luquillo, or of the little Madman, on Account of a revolted Indian [that withdrew to it. The highest Point of it is call'd Furzidi, a Name given by the Blacks, signifying a place always clouded, and the third is call'd of the Holy Ghost."

[2] U. S. Coast and Geodetic Survey Chart 920, issued July, 1910.

[3] These two together appear to be given the name "El Cacique" (The Indian Chief) by Gifford. He also names the round mountain to the west "El Toro" (The Bull), and the mountain next to it on the south "El Carnero" (The Sheep).



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OPENING IN VIRGIN STAND OF MIXED TROPICAL HARDWOODS. RAIN-FOREST FORMATION NEAR LA ISOLINA (ARECIBO).

elevation of 1,341 meters (4,398 feet), while "Mt. Guilarte," commonly considered second to El Yunque, is 1,204 meters (3,950 feet).

The many lateral ridges which diverge from the central mountains, mostly from the north side, are commonly very steep-sided and narrow-crested, and the valleys are deep, V-shaped, and almost devoid of level bottom land. Rock outcrop is generally infrequent, except toward the outer portion, where the ridges are often capped with hard limestone.

The central mountains are composed largely of black or other dark-colored igneous rocks, which occur in the form of tuffs, conglomerates, silts, and an occasional dike of diorite. Their volcanic forms have been destroyed by erosion. The material thus worked over into sediment in prehistoric ages now occurs in well-defined strata. Two relatively inconspicuous limestone formations also occur, one black, bituminous, and shaly, and the other light gray and crystalline.

As a result of the almost uninterrupted action of an abundant precipitation, a high relative humidity, and a warm temperature, rock weathering at the higher elevations is more rapid than erosion, as shown by a soil mantle of unusual depth and almost no bare indurated rock here. The characteristic soils are deep, reddish clay loams and tenacious red clays. So cohesive, unctuous, and compact are these soils that they are able to maintain themselves in an almost vertical position. Cultivation, in consequence, is in many places carried on to the very tops of the ridges and on the steepest slopes, yet evidence of excessive erosion and landslides is surprisingly inconspicuous. At the lower elevations the sandy character of the soil and the more common occurrence of outcrop show that the rate of rock erosion has exceeded that of weathering.

THE CORAL LIMESTONE BELT.

The belt of coral limestone is several miles wide in places and on its interior border overlaps the igneous rocks. This area is of sedimentary origin. Where rock solution has been the most active agent of decay, it retains the general form of a table-land. Where erosion has been the most active only isolated conical hills remain. In certain parts of the island the limestone extends directly to the water's edge, where it terminates in steep scarps, often 100 feet or more in height, notably on the south coast west of Ponce and on the north coast west of Quebradillas. Elsewhere on the island the remnants of this formation stand as steep, sloping, solitary mounds or domes, which rise singly or in chains above the coastal plain.

Along the junction of the central mountains and the limestone belt is a distinct line of weakness marking the former shore line. Strong valley lines are developed there, separating the two physiographic regions. These "parting valleys" are especially well developed on the

south side of the island in the valley of the Guanajibos at Sabana Grande, and on the north side at the junction of the Don Alonso (or Limón) and Arecibo Rivers.

An uninterrupted block of limestone formation, known in places as the Pepino Hills,[1] occurs along the north side of the island from Ciales nearly to Aguadilla, and is some 6 to 10 miles wide from north to south. It offers a marked contrast to the low rounded limestone hills which flank it to the north, because of its greater elevation, rough, angular topography, pitlike valleys, bare rock outcrops of chalky whiteness, and subterranean drainage. Wherever the large rivers, such as the Rio Grande de Arecibo and the Manati, cross this area they have cut deep canyonlike valleys whose sheer cliffs of considerable height occasionally rise directly from the water's edge. Otherwise the area is strikingly devoid of surface drainage features. The hills are very closely packed together, their connecting ridges hardly more than rocky septums separating the disconnected pitlike valleys. The steep-sided depressions show, on a tremendous scale, to what an enormous extent rock solution takes place under tropical conditions.

The region, if viewed from above, would look like a honeycomb. Not infrequently the "sinks" are 100 feet and occasionally 200 feet or more deep. The larger pits sometimes contain an acre or more of bottom with a very fertile soil, commonly under cultivation to such crops as coffee, bananas, and ground provisions. The bottoms of others are occupied by bogs or small lakes. The crags and summits are almost invariably wooded. Caves, which mark the early stages of pit formation, are common.

Travel here is extremely difficult. Roads are out of the question and the trails are not numerous and are extremely rough. There is no alternative but to cross the pits in succession, descending to the bottom of one and then climbing to the rim of the next almost straight down and straight up again.

THE COASTAL PLAIN.

The sandy ridge fronting the coast forms a barrier between the sea and a narrow low-lying area scarcely above tidewater level, and partly marine and partly alluvial in origin. On the north side of the island there are many swamps and lagoons covered with a thick growth of mangrove bushes. The most typical are the Caño y Laguna de Tiburones between Arecibo and Barceloneta, Laguna del Tortuguero north and east of Manati, and the string of lagoons east of and connected with the harbor of San Juan. On the south side,

[1] The term "pepino" (cucumber) undoubtedly refers to the appearance of the elongated mammillary summits of the hills. An equally characteristic term, "cockpits," applied to a similar formation in Jamaica is descriptive of the valley bottoms.

the mangrove is only slightly developed, but there are in places extensive saline plains too low and wet for cultivation, where rank grasses, a few scattered acacias, or low, succulent, salty herbs constitute the only vegetation.

The coastal plain proper is elevated but a few feet above the sea, and has but a slight gradient toward the mountains. It terminates rather abruptly at the foothills, except in the valleys of the larger rivers. These plains are entirely sedimentary, having been laid down when the island stood at a somewhat lower level than now.

The coast-plain hills are isolated, low, and dome-shaped. Some have been nearly buried by the alluvial deposits of the rivers; others rise 100 feet or more above the level of the plain.

The soil, except on the hills, is largely a fine, rich alluvium, sandy in places, and is almost entirely under cultivation or in pasture.

DRAINAGE.

It would be difficult to find another country of its size so well watered as Porto Rico. Within the mountainous area are many swift-flowing streams which have cut for themselves deep, steep-sided valleys. In their upper courses they traverse steep, angular gorges, where numerous cascades and cataracts are to be found, particularly in the Sierra de Luquillo. The peculiarity of the drainage system where it passes from the central mountain into the limestone region has already been described. Within the coastal plain the valleys are broad, with considerable areas of bottom land through whcih the rivers pursue a meandering course. The streams flowing north from the main divide are much more numerous and longer than those from the south side, and they likewise carry a much greater and more constant volume of water. The island is reported to have upward of 1,300 named streams, of which the Rio de la Plata is considered the longest, about 45 miles. None of the rivers is navigable, except for small boats, and then chiefly in their tidal reaches. They, nevertheless, are of tremendous importance as a source of domestic water supply, and their power possibilities are also very considerable.

CLIMATE.

WINDS.

Though Porto Rico is well within the Tropics, it has an equable and comfortable climate, for the modifying influences of the ocean are accentuated by its position in the direct path of the North Atlantic trade winds. These counteract the enervating effect of the high temperature and humidity, the occasional periods of sultry and oppressive weather invariably occurring when they fail. They vary in direction from northeast to southeast, usually coming from east or east-southeast. Their average velocity from month to month is

remarkably constant, rarely varying more than a mile from the annual average of 11 miles per hour, excepting in July, when the velocity rises to 13 miles, and in October and November, when it falls to 8 or 9 miles.

Hurricanes whose centers pass over the island are rare; in the past 40 years there have been but three, the most recent as well as the most destructive being that of August 8, 1899. The recorded storms of this character for the entire West Indies average about one a year and occur chiefly during the months of August, September, and October.

TEMPERATURE.

The temperature throughout the year is uniform. The records of the United States Weather Bureau for a period of more than 10 years show a combined average annual temperature for over 40 stations in the island of 76°; during the coolest months of winter the average is 73° and during the warmest months of summer 79°. The daily range is much more than the seasonal range; thus at San Juan the difference between the afternoon and early morning temperature is 10° or 11° and at an inland station may be as much as 20° or 25°. In the afternoon the temperatures along the coast rise to an average of 84° in the winter months and to 89° in the summer months and in the early morning fall to 66° and 73°. In the hills and mountains of the interior the average daily maximum is about 81° in winter and 87° in summer, while the corresponding minima are 61° and 68°, respectively.

The extremes of temperature recorded during the past 10 years do not differ greatly in different portions of the island. At the more elevated stations the maximum range is between 90° and 95° and along the coast and in the valleys 95° and 100°. The extreme maximum has reached 100° only three times during the 10 years, at one time reaching 103°. The minimum temperatures range between 50° and 55° except for stations on the immediate coast, where the temperature seldom goes below 60°. The lowest recorded temperature is 43°, and it is probable that on the highest elevations it goes somewhat lower. It is, however, extremely doubtful if it ever approaches very near to the frost line.

RAINFALL.

The average annual rainfall is much more variable than the temperature. The average for a 12-year period from 44 stations shows 77.30 inches; for the year 1901 it was 93.72, and for 1907 but 64.18. The geographic distribution of rainfall shows a still wider variation. The heaviest is recorded in the Sierra de Luquillo, which is exposed to the full sweep of the moisture-laden trade winds. The average annual rainfall here exceeds 135 inches, with a maximum

record in 1901 of 169 inches. There are two other well-defined areas where the average annual rainfall exceeds 100 inches, namely, the peaks about Adjuntas and the mountains surrounding Las Marias and Maricao, San Sebastian, and Lares, in the central and west-central portions, respectively, of the Cordillera Central. These centers of heavy precipitation are likewise centers of heavy forestation. Except for the Luquillos, the forests are artificial ones, being largely coffee plantations, yet their influence on climate is in all respects similar.

While abundant rain and the absence of protracted droughts characterize conditions on the north side of the island, the reverse obtains to the south, where several months may elapse with little or no rain. Here precipitation is not only scanty but unevenly distributed throughout the year. The average annual rainfall for the stations along and near the south coast is 45 inches. The minimum average annual rainfall of 37 inches is recorded at Guanica, while 21 inches in 1907 is the absolute recorded minimum of recent years.

The rainfall on the whole island increases from 11 inches in the winter months (February being the lightest) to 16 inches during the spring, 23 inches during the summer, and 26 inches during the fall. The maximum generally occurs in September on the east coast, in October along the south coast, and in November along the north coast. The rainfall is largely in the form of showers, which, although frequently very heavy, seldom last over 10 or 12 minutes. Rain for a day or more at a time is comparatively rare.

Rain falls practically every day in the year over some portion of the island, except possibly a few days in February. For the island as a whole the average number of days in a year with rain is 169, the minimum and maximum frequency are 28 at Guanica on the south coast in 1907 and 341 in the Sierra de Luquillo in 1900, respectively. The average humidity for the island is about 78 per cent, the minimum in the driest month, 75 per cent, and the maximum in the most humid, 81 per cent.

LAND DISTRIBUTION, UTILIZATION, AND TAXATION.

Land Distribution.

The land policy of Spain appears to have been conceived in a spirit of great liberality. It not only provided for the usual extensive grants to the grandee and to the soldier of fortune, but also offered encouragement to the bona fide settler of small means. The first law,[1] promulgated by Ferdinand V under date of June 18, 1513, a scant 20 years after the discovery of America, granted settlers free title to holdings of something in excess of 170 acres, upon compliance with

[1] "Law First" (See Recapitulation de Leyes de los Reinos de las Indias, Book 4th, Title 12th). Translation by Bureau of Insular Affairs, War Department.

certain requirements concerning residence and cultivation, resembling very strikingly our own national homestead act, passed 350 years later.

GOVERNMENT LANDS.

By 1830 the Government had disposed of approximately half of the island, and between that time and the Spanish-American War had given away about nine-tenths of the remainder. The rest of the Crown lands, which, by the Treaty of Paris, December 10, 1898, became the property of the United States, amount, as nearly as can be ascertained from the records,[1] to 147,971 acres, of which 7,400 acres are classified as swamp land. These lands, except a small amount reserved for Federal use, were ceded by act of Congress approved July 1, 1902, to the people of Porto Rico. Some 3,000 acres in addition have reverted to the local government in default of taxes. Thus the entire public domain, including Federal and insular lands, amounts to less than 151,000 acres.

By far the greater part of this land lies in the mountains. Except for a few of the more accessible tracts, comparatively little is known about its present condition, or even its location, since in only one or two instances has any survey or detailed examination been made. General information gathered in the vicinity of some of the larger tracts indicates that only a very small amount of this land supports a productive forest, except a tract in the Sierra de Luquillo. The greater part is at present an idle, unproductive, grass or brush covered waste. In some few instances it is so situated as to be suitable for coffee culture, but in the aggregate it is of slight agricultural value, though it has a large potential value as forest land.

PRIVATELY OWNED LANDS.

Figure 2[2] indicates for the years 1828, 1900, and 1912 the comparative areas of public lands and of private lands under cultivation to different crops, under pasture, and under forests.

In 1828, while slightly over half of the island was privately owned, scarcely more than 3 per cent was under cultivation. Agriculture was then carried on largely for the production of home staples. Thus plantains, Indian corn, and rice covered more than half, while the commercial agricultural staples of to-day, cane, coffee, and tobacco, together covered scarcely one-fourth of the whole cultivated area. Between 1828 and the end of the Spanish régime the area under cultivation had increased to about 13 per cent. Nearly half of this was in coffee, and somewhat more than one-fifth of the remainder in cane.

[1] See report of the Commissioner of the Interior for Porto Rico, 1909.

[2] Compiled from Flinter's "Porto Rico," containing the official returns for 1828, from Knapp's "Agricultural Resources and Capabilities of Porto Rico," and the summary of tax assessment (corrected to Aug. 10, 1912) in Report of the Governor of Porto Rico, 1912.

During the same period the area of so-called pasture land had more than doubled, so that it exceeded in extent all the other land classes combined, and privately owned forests had increased slightly. Private ownership was thus almost doubled, having absorbed nearly 95 per cent of the total land area.

During the period of American occupation the cultivated area has nearly doubled, amounting in 1912 to 23.28 per cent.[1] Of this area cane covers a trifle more than two-fifths, coffee more than one-third, minor fruits about a fifth, and tobacco, coconuts, oranges, and pineapples, in the order named, the remainder. This agricultural expansion has been carried on about equally at the expense of "pasture" and "timber and brush" lands. On account, however, of the much greater area of pasture lands, these were relatively little affected in the aggregate, while the forest lands were reduced nearly two-fifths.

There is no information available showing the average-size holdings in the various classes of property or in what proportion the economically developed lands are held in conjunction with the waste and forested lands. The data upon which the diagrams (fig. 3) are based most nearly approach this information by showing for the assessment area analyzed the proportion of the total, "by number" and "by area" of the farms in certain acreage groups.

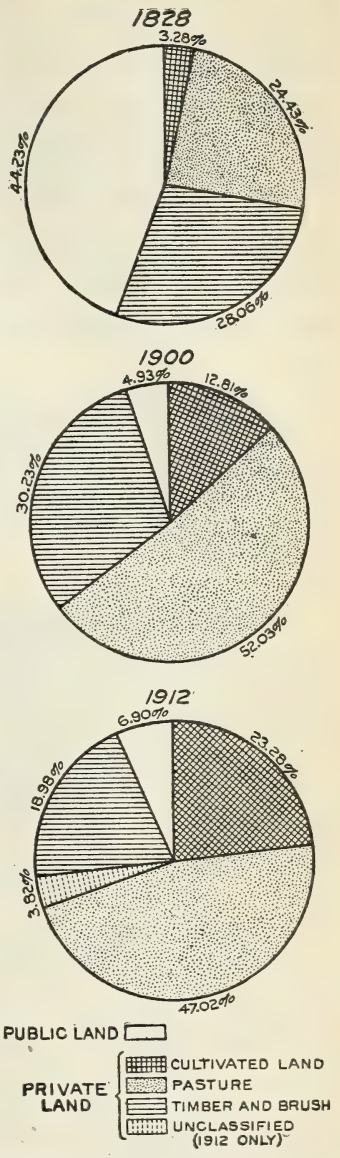


FIG. 2.—Land in Porto Rico. The changes from public to private ownership and the main uses to which it is put.

[1] This figure differs from the one (56 per cent) given in the Register of Porto Rico for 1910, which also varies from the so-called "improved area" (75.3 per cent) given by the Thirteenth Decennial Census (1910). Both of these percentages have included in them a considerable area of so-called "pasture" land. The grass land in the low country might be considered "improved," because it is used part of the time as pasture and is then plowed up and put into cane, but it is impossible to conceive of more than one-fourth to one-half of the total of land classified as "pasture" as being thus alternately cropped and pastured. This would make the "improved" acreage aggregate 35 to 50 per cent of the total territorial domain. The remaining one-half to three-fourths of the land classed as "pasture" could more properly be classed as waste land or "ruinate," as is done in Jamaica and elsewhere, because it serves no productive economic use.

We find 91.34 per cent of all farms have an area less than 100 acres each, which would indicate a wide popular distribution of the land in small holdings. But the average area per farm in this group is only 21.4 acres; so that by far the greater number of individual holdings must be much less than 20 acres.[1] It is not surprising, therefore, that the remaining 8.66 per cent of the whole number of farms covers 55 per cent of the total farm area, or that these farms have an average of about 280 acres per farm.

With 93 per cent of the land in private ownership, the success of any reforestation work attempted by the Government will depend in a large measure upon the cooperation which can be secured from the private landowner. The conditions are the most unfavorable in the mountain region, where there is a considerable proportion of

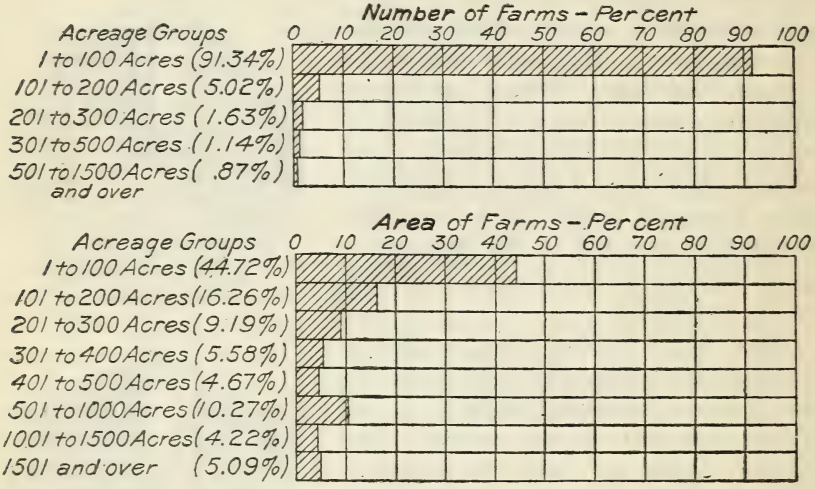
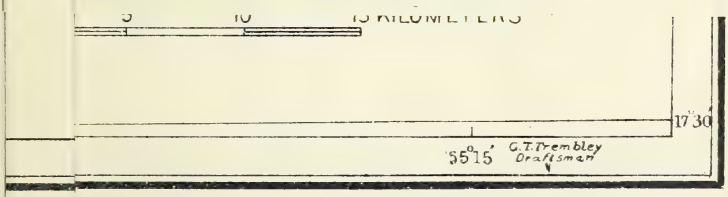


FIG. 3.—Distribution of land ownership in Porto Rico by acreage groups and number and area of farms. From data compiled by bureau of property taxes, Government of Porto Rico.

small holdings, from which as a class very little cooperation can be expected. In addition to the small farms, there are a few coffee and tobacco plantations. Much of the land, however, is not even under small-farm cultivation. Vast stretches of it are nothing more than grass land, which is classed for assessment purposes as "pasture." In the coastal country the holdings are larger and offer better possibilities for cooperation. Many of the coast hills are already wooded, while others have been cleared for pasture. Here the need for forests on account of their protective influence on water and soil is not of importance, but the demand for wood is obviously urgent. Forests are needed in this particular section also as a refuge for birds, which are an important factor in controlling insect pests in the cane fields, besides being of esthetic value.

[1] According to the census of 1899, 51 per cent of all farms were less than 5 acres in extent, while the Thirteenth Decennial Census (1910) reports 72 per cent of all farms less than 19 acres in extent.



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U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
HENRY S. GRAVES, FORESTER
PORTO RICO
AND CONTIGUOUS ISLANDS
UNDER ITS JURISDICTION
FROM DATA BY THE WAR DEPARTMENT
U.S. COAST AND GEODETIC SURVEY AND
DEPARTMENT OF THE INTERIOR
OF PORTO RICO
LEGEND
Insular Forest Reserve
Insular Road Proposed
Trail
Telephone Line through or
Telegraph Line through or
Lighthouse
SCALE APPROXIMATELY 5 MILES=1 INCH
STATUTE MILES
KILOMETERS

Land Utilization.

Porto Rico is essentially an agricultural country and will undoubtedly continue as such. Of its commercial staple crops—sugar, coffee, and tobacco—only the first two are important competitors of the forest from an acreage point of view, tobacco occupying less than 1 per cent of the insular area. Coffee cultivation is a most satisfactory form of agriculture for the steep mountain slopes where it is carried on and its replacement of the forest is usually justified, for it exerts many of the beneficial influences of the forest and few of the detrimental ones of the field crops. Sugar might be said to offer little economic competition with forests, because it usually occupies the more level and strictly agricultural soils.

Cattle raising was early taken up, and there was formerly a very considerable export trade in live stock, hides, and tallow. The total live stock now on the island amounts to not more than 350,000 to 400,000 head, and there is no export trade whatever. Cattle and horses make up nine-tenths of the stock (cattle alone three-fourths), the larger part of which is work stock. These are, to a considerable extent, used in the low country and are grazed in the pastures there. There seems, therefore, to be little economic justification for any longer retaining the bulk of the cleared uplands in pasture. Their partial or complete reforestation would add materially to the productive wealth of the island.

It is in the cultivation of native ground provisions—rice, yams, and the like—that agriculture comes into closest contact with the forest. From time immemorial, not only in Porto Rico but throughout the Tropics the world over, the same primitive agricultural practice has prevailed. Wherever it is in operation the "conuco," or by whatever other name [1] the method is known, is essentially the same. Upon the area which it is desired to cultivate all the trees are felled and set on fire. Sometimes the larger ones are killed by girdling and allowed to remain standing. Clearing is most apt to occur during the dry season, when conditions are most suitable both for burning and for planting the new crop. Little or no care is taken to control the fire and it often burns over a far greater area than is wanted for cultivation. The beans, rice, or other ground provisions are planted immediately following the burning, the ashes having enriched and sweetened the soil. Little or no cultivation is given the crop, and cropping seldom continues for more than 3 years. Eventually, as the fertility of the soil decreases and grass, weeds, and other volunteer growth get the upper hand, the area is abandoned and a new clearing made.

[1] What is known as the "conuco" in Porto Rico and other of the Spanish West Indies is known in the Philippines as caiñgin, in India variously as jhum, kumri, and khil, in Burma as juangya, and in Ceylon as chena or hena. The same practice is also reported from the Sudan, Central America, and many other parts of the Tropics.

The best types of forest are invariably the ones first selected, because they give the richest ash and are less difficult to clear than areas of small, thorny growth. Thus for a meager crop of native provisions a valuable timber crop is destroyed, which it will require a generation and more to reproduce.

Where the amount of available land is scarce an area may be successively cut over several times at intervals, the parts cleared becoming naturally reforested again between cuttings. Where, however, climatic, particularly moisture, conditions are not favorable it may be difficult or impossible for the forest to reestablish itself in competition with a grass cover. In such cases the succeeding forests may grade from a dense thorny growth through chaparral and low brush, or a very fragmentary scattered tree growth, to open savanna and even desert. It is almost certain that the vast and almost totally unproductive area of so-called pasture land in the central mountain section is the direct result of this practice, which is even now being extensively carried on in all its primitiveness.

The total lack of property survey, lax title registration, and the free and unmolested operation of the prescriptive right have made it easy for this devastating practice to thrive. Legislation can and ought promptly to be undertaken to eliminate these contributory causes. But the government must go farther. There must be a serious educational campaign combining, unifying, and extending the work of the public-school system, the agricultural experiment station, and any other agencies working for rural betterment, until there can be instilled into the mind of the "conuco" farmer a proper regard for the fundamentals of economic agriculture, by which continuous cultivation under a suitable rotation of crops will be substituted for the present nomadic system. To give force and effect to that campaign the government must, of course, provide these people with the means of acquiring the land and other essentials to the practice of such improved agriculture.

Taxation.

The same archaic provisions are in force in Porto Rico for the taxation of forest property as are to be found throughout the United States. The system of taxing the forest annually is unjust and discriminatory, encouraging forest destruction. In a country like Porto Rico, with practically no forest resources, it becomes prohibitory as well. Certainly few will elect to plant new forests or apply forestry to improve the productiveness of forests already there if by so doing they merely invite an increased assessment and taxes. The system, in fact, offers a distinct incentive to the owner to destroy what timber there is, so that there will remain but the bare land to tax.

Under these circumstances the law should make it possible for the forest to be classed as a crop. The growing of a forest is no less desirable to encourage than the growing of a crop of sugar cane, coffee, or tobacco; yet these latter are exempted entirely from taxation, while the forest is classed as an "immovable" and taxed annually at its full value. There is little wonder, under these circumstances, that no effort is made to practice forestry, which would inevitably increase the extent and value of the forest; or that the value of this class of property has decreased regularly from year to year, and for the fiscal year 1912–13 amounted, both timber and land together, to but 3.3 per cent of the total assessed value of all real property.

The law should at least provide that the land and timber be classified, assessed, and taxed independently of one another. The average forest crop requires several years, often decades, to mature. During this period it yields little or no revenue whatever. It is only fair to the producer of such a crop that his taxes be arranged to fall due in large part at the time when the crop matures and is sold. This may be accomplished in one of three ways. If the owner pays throughout the entire period a tax based on the full productive value of the bare land, then the timber should be exempted entirely. At most it should be taxed but once—on its sale value as it stands in the forest in the year that it is cut. The rate in this case should be the same as that applied to all other real and personal property for that particular year. A second method is to defer collecting any tax on the land until the timber is cut and then to take both the land and timber tax out of the sale value of the standing timber in that year. The rate in this case would, of course, have to be considerably higher than the general property tax rate and would properly be graduated according to the length of the period since the previous tax was paid. A combination of these two methods, modified according to circumstances, though less just to the landowner, would be at once an advance over the present plan and the most likely to be acceptable to the community. Thus an annual tax on the land would be levied either at the full general property rate on a nominal fixed value for the bare land or at half or other fractional part of the general property rate on the full productive value of the bare land. Then when the timber was cut, it, too, would be taxed, but at a rate correspondingly higher than the general property rate, say 10 per cent.

Porto Rico is fortunate in that it has no constitutional obstacles to remove before it can proceed to a change. Neither the organic act nor any of the subsequent acts of Congress puts any specific restrictions on taxation. It is only necessary, therefore, in order that this unjust discrimination against forests and forestry may be removed, to induce the legislative assembly to amend the present law.

A decidedly favorable feature of the present taxation system of the island is its centralized organization. The insular government assumes the responsibility for the assessment and collection of all taxes, general and municipal, thus reducing the chances of inequalities being introduced between urban and rural properties, and between similar classes of property in different municipalities. Until, however, there can be effected a complete cadastral survey of the island, making possible the enforcement of compulsory title registration and the assessment of land values based thereon, any system of taxation, no matter how adequate, must, as now, be a dead letter in its real property provisions; and the present practice of "distraining personal property for all taxes due and only proceeding on real property when no personal property exists" must continue.

POPULATION.

Porto Rico has had a steady increase in population since Columbus found 30,000 native Indians [1] on the island, except in the early years of settlement, when through conflict, disease, emigration, and slavery, the native population was rapidly reduced to a state approaching extinction. Although it was reported in 1543 that but 60 Indians remained on the island, it is probable that relatively pure Indian stock persisted in the mountainous sections up to comparatively recent times.[2] Here, too, the aboriginal type of feature is readily discernible to-day and the primitive method of "conuco" cultivation is most commonly encountered.

Because of extensive slave importations almost from the beginning of settlement and the correspondingly slow colonization up to the middle of the eighteenth century, as late as 1820 the negro population outnumbered the white by 5 to 4. At present, however, the white race dominates all others by more than 7 to 4. Except for Cuba, there is no other island in the West Indies where this condition is even closely approximated, all but two showing 10 per cent or less of white people. Porto Rico has also a smaller proportion of negro population than most of the southern seaboard States.

The density of population in Porto Rico is phenomenal, particularly as there is a great preponderance of rural inhabitants. It is exceeded in but few of the other West Indies, is 1 per cent more than in China, and slightly more than in Japan. Porto Rico, with 325.5 persons per square mile (79.9 per cent rural), ranks fourth among the political subdivisions of the American territory,[3] after Rhode Island with 508, Massachusetts with 418.8, and New Jersey with 337.7. On the

[1] Fewkes, Jesse Walter, "The Aborigines of Porto Rico," 25th Annual Report, Bureau of Ethnology, 1907.

[2] Flinter (see bibliography) remarks that there were in 1832 Indian families living in the mountainous interior.

[3] Thirteenth Decennial Census (1910).

basis of rural population alone, Porto Rico, with 260 country people per square mile, outnumbers its nearest competitor, New Jersey, by more than 3 to 1, and Rhode Island by 17 to 1. Furthermore, Porto Rico's rural population density alone outranks the total population density of any but the three States mentioned (fig. 5).

The distribution of population in Porto Rico is remarkably even, and the centers of area and population are less than 5 miles apart

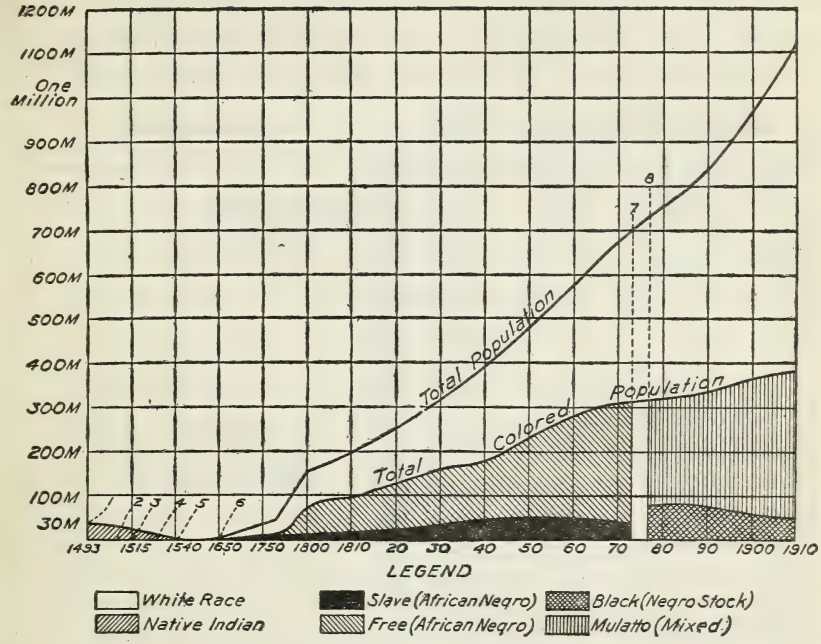

FIG. 4.—Growth in population in Porto Rico.

1. 1493. Island discovered by Columbus. Pre-Columbian population (Fewkes).
2. 1508. First white settlement under Ponce de Leon.
3. 1515. Indians imported from Jamaica and other West Indies in servitude (Fewkes).
4. 1530. First numerical record concerning importation of African negroes (census 1899).
5. 1543. Bishop of San Juan reported to the King of Spain but 60 native Indians remaining on the island (census 1899).
6. Total population middle of seventeenth century, 880 (census 1899).
7. Slavery abolished by act of the Spanish Revolutionary National Assembly, March 22, 1873.
8. Census of 1877 adopted new classification dividing the colored population into "mulattoes" and "blacks," which it will be seen closely conforms to the earlier classes of "free" and "slave" (census 1899).

in a direct line.[1] The center of population lies to the north of the center of the island, because of the more equable climatic conditions, the greater area of arable land, and the location of the capital and largest city, San Juan, on the north side.

[1] The center of area of the island is situated 3 miles north and 2.1 miles west of the town of Barros, and the center of population (1899) was 6.6 miles west and 2.4 miles north of the same town, making the two points distant from each other 6 miles east and west and 4.5 miles north and south. (Census of Porto Rico, 1899).

Occupational statistics show that 33 per cent of the total population [1] are engaged in gainful occupations, and that 62.8 per cent of that number are engaged in "agriculture, fisheries, and mining," the two latter of which are almost negligible.[2] Almost three-fourths of the men and boys engaged in any gainful occupation are employed directly in agriculture. Literacy is a feature of population statistics which has changed so considerably since the American occupation that but little value attaches to the 1899 figures, which are the latest available. Some idea, however, can be gained by a comparison of the school attendance, which has increased from between 2 and 3 per

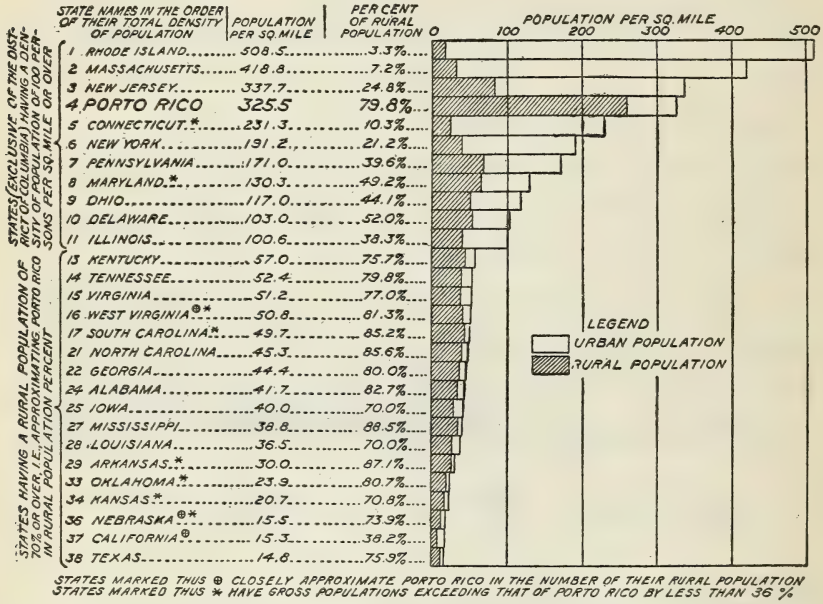
STATE NAMES IN THE ORDER OF THEIR TOTAL DENSITY OF POPULATION
POPULATION PER SQ. MILE
PER CENT OF RURAL POPULATION
POPULATION PER SQ. MILE
0
100
200
300
400
500
STATES (EXCLUSIVE OF THE DISTRICT OF COLUMBIA) HAVING A DENSITY OF POPULATION OF 100 PERSONS PER SQ. MILE OR OVER
STATES HAVING A RURAL POPULATION OF 70% OR OVER, I.E. APPROXIMATING PORTO RICO IN RURAL POPULATION PERCENT
1 RHODE ISLAND 508.5 3.3%
2 MASSACHUSETTS 418.8 7.2%
3 NEW JERSEY 337.7 24.8%
4 PORTO RICO 325.5 79.8%
5 CONNECTICUT.* 231.3 10.3%
6 NEW YORK 191.2 21.2%
7 PENNSYLVANIA 171.0 39.6%
8 MARYLAND.* 130.3 49.2%
9 OHIO 117.0 44.1%
10 DELAWARE 103.0 52.0%
11 ILLINOIS 100.6 38.3%
13 KENTUCKY 57.0 75.7%
14 TENNESSEE 52.4 79.8%
15 VIRGINIA 51.2 77.0%
16 WEST VIRGINIA ⊕* 50.8 61.3%
17 SOUTH CAROLINA* 49.7 85.2%
21 NORTH CAROLINA 45.3 85.6%
22 GEORGIA 44.4 80.0%
24 ALABAMA 41.7 82.7%
25 IOWA 40.0 70.0%
27 MISSISSIPPI 38.8 88.5%
28 LOUISIANA 36.5 70.0%
29 ARKANSAS.* 30.0 67.1%
33 OKLAHOMA.* 23.9 80.7%
34 KANSAS* 20.7 70.8%
36 NEBRASKA ⊕* 15.5 73.9%
37 CALIFORNIA ⊕ 15.3 38.2%
38 TEXAS 14.8 75.9%
LEGEND
URBAN POPULATION
RURAL POPULATION
STATES MARKED THUS ⊕ CLOSELY APPROXIMATE PORTO RICO IN THE NUMBER OF THEIR RURAL POPULATION
STATES MARKED THUS * HAVE GROSS POPULATIONS EXCEEDING THAT OF PORTO RICO BY LESS THAN 36 %

FIG. 5.—Comparative density of populations, showing graphically the relative position of Porto Rico and certain selected States.

cent of the total population during the year following the close of the Spanish-American War to 14.4 per cent in 1912.[3] In 1899, of the total population over 10 years of age, only 16.6 per cent could read.

TRANSPORTATION.

The mountainous character of the island, the heavy and unctuous qualities of the soil, and the excessive rainfall conspire to render road building both expensive and difficult, so that until comparatively

[1] This low percentage of persons engaged in gainful occupations is occasioned largely by the abnormally large number of women and of children under 10 years of age, most of whom are enumerated in the dependent class. Thus 30.9 per cent of the total population are children under 10 years of age, and 43.9 per cent under 15 years. (Census, 1899).

[2] The census of 1899 showed but 455 fishermen and 48 miners or quarrymen on the entire island.

[3] Report of the Commissioner of Education (Annual Reports, War Department, fiscal year ending June 30, 1912, Report of the Governor of Porto Rico).

recently roads and other means of travel in Porto Rico have been poor. This confined early settlement and development to the seaboard and delayed the opening up of the interior. Then, too, the products of one section have not been sufficiently different from those in another to sustain an intra-island trade either by land or water. These circumstances and the system of trading which flourished between the West Indies, Europe, and America until recent times made the ports of the south coast, for instance, each commercially closer to Bilboa and Cadiz and to the world ports in general than to San Juan or each other. San Juan in particular, being formerly the last port of call on the voyage to the Old World from Gulf and Caribbean ports, often found it easier to get timbers and other natural products from Santo Domingo than from the immediately adjacent country or a neighboring Porto Rican port. The fact that for over a century Santo Domingan timbers have been in common use in San Juan has led to the belief that Porto Rico was never well timbered or that what large material there was soon became exhausted, whereas the lack of adequate internal transportation facilities offers a more likely explanation.[1]

This paucity of transportation facilities persisted until well past the middle of the last century.[2] The famous military road, the main artery of the projected plan for highways under Spanish sovereignty, was commenced about 1842 and finally completed in 1888, with a total length of 134 kilometers (about 84 miles). The remaining mileage of improved roads, which aggregated 275 kilometers (about 175 miles) at the close of the Spanish régime in 1898, largely comprised isolated sections of several road projects. From the American occupation to June 30, 1912, 794 kilometers (500 miles) of macadam road have been constructed, making a total of 1,069 kilometers (670 miles). These are largely trunk-line roads, from which extend many dirt roads suitable for the bull cart and like vehicles, while beyond these are mountain trails where pack and saddle horses and the land canoe, or flat-bottomed dugout hauled by oxen, are still the only means of transportation.

It is usually only rough mountain trails that reach the "conuco" farmer, the forested area, and many of the coffee plantations. These trails are mostly in very bad condition. Absolutely without drainage,

[1] One can see the effects of similar conditions in operation to-day in Santo Domingo. With 85 per cent of her land area under virgin forests, a sixth of which is pine, Santo Domingo imported from the United States in 1911 forest products to the amount of $130,800, including 3,937,000 board feet of lumber, valued at $91,296, and shooks and other unmanufactured timber products, exclusive of naval stores, valued at $12,206 additional.

[2] Robin (see bibliography) in 1802–1806 testifies not only to the poor transportation facilities, but to the abundant forests, in the following reference: "The island of Porto Rico is still little inhabited, in spite of the earliness of its settlement. * * * The habitations, isolated and dispersed over the island, lack communication with one another. * * * It is, however, not necessary (in order to provide roads) to cut the mountains, raise the valleys, or fill the marshes, but simply cut down the large and vigorous trees."

the tenacious clay soil, already saturated with moisture, has kneaded into it additional water through the travel of the bulls and heavily burdened pack animals until in places it becomes a semifluid mass resembling thick orange-red paint, often of a depth reaching to a horse's belly. During the dry season, when they dry out on top and crust over, these "baches" are even more treacherous than in their semifluid state, for when a horse breaks through the crust he is the more liable to get mired. Only horses bred to this kind of travel know how to handle themselves under such trying conditions.

For draft purposes in this back country the bull is almost exclusively used. Most of the freighting across the island and into the interior is even now, and on the best roads, done by bull carts, except for a short line of railroad between Rio Piedras and Caguas. Very recently the auto truck and auto stage have been tried in the cross-the-island freight and passenger service, as well as along the coast, and their use unquestionably will be extended.

At the time of the American occupation there were 254 kilometers (about 160 miles) of narrow-gauge railroad in operation in the coastal portion of the island. At the present time (1912) it is possible, through the connections established between the various sugar companies' railroads and the original public-service road, almost to encircle the island by rail.

THE FOREST.

The forests of Porto Rico are now so fragmentary and so limited in extent and have been so materially modified by the acts of man during several centuries that they afford of themselves little basis for classification and description. Clearings, severe cuttings, and the culling of the more desirable timbers were noted by the earliest travelers. Then, too, many native species have been transplanted from their natural haunts to others and many introduced species have been brought in and spread over the island. It has consequently been necessary to draw extensively on information from a number of sources and to study the various formations as they have been described in their undisturbed natural state in whatever other part of the Tropics they could be found. In this manner only could a groundwork be obtained for classifying and distributing according to their proper relations the remnants of the once extensive Porto Rican forests.[1]

[1] In describing the fundamental features of the various formations the works of Schimper and of Broun particularly have been freely drawn on, and in reference to special features those of Harshberger, of Fernow, and Taylor, and of Woodward (see Bibliography), not to mention the various historical works which have contributed side lights on matters of general distribution.

The work of defining the distribution of formations is a comparatively simple one, because of their close relation to the distribution of rainfall, which latter has been carefully charted by the local Weather Bureau

F–19765A

FIG. 1.—AN UNIMPROVED COUNTRY ROAD THROUGH THE LOWLANDS.

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FIG. 2.—NATIVE MEANS OF TRANSPORTATION WHICH REQUIRES NO ROADS.

COUNTRY ROAD AND NATIVE TRANSPORTATION.

FORESTED CONDITION AND DISTRIBUTION.

There can be little doubt that Porto Rico was at one time forested from the shores of the Atlantic to the Caribbean, from the Virgin Passage to Mona.[1] Historians, while in general silent as to the extent and character of the forests on the island, have in the aggregate left a considerable collection of data concerning the subject,[2] sufficient it would seem, together with present-day indications, to bear out the contention of a once completely forested Porto Rico.

One has but to turn to the neighboring islands of the Greater Antilles, which are closely related both geologically and botanically, if further corroboration of Porto Rico's original forested condition is required. This close relationship and similarity even down to such details as common names is strikingly brought out by a comparison of the description by Fernow and Taylor [3] of the Sierra Maestra in Cuba, by Woodward,[3] of the Santo Domingo forests, and by Gifford,[3]

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office. Slight departures only are necessary to make allowance in certain cases for the influence of the limestone soils. Altitudinal differences are so slight as to have comparatively little effect.

In the descriptions local names, wherever possible, have been adhered to, and following each such name is a number in parentheses, thus, guaraguao (74), which number refers to the specific description in Appendix I, "The Trees of Porto Rico."

Whenever desirable, a brief paragraph in small print concerning the chief features of the same or a closely related formation in other parts of the Tropics follows the description of the local Porto Rican formation. Thus it is hoped that interest in the forest will be heightened through comparison and that the way may be opened for the judicious selection of new species to be introduced into Porto Rico.

[1] The following from a letter from Mr. Alex. Wetmore, assistant biologist, Bureau of the Biological Survey, U. S. Department of Agriculture, who recently completed an exhaustive study of the bird life of the island, is of considerable interest in this connection: "On examining the endemic species of Porto Rican birds, I find that with one or two exceptions they are forest-inhabiting forms, pointing thus to a very extensive forest area on the island. The forms as differentiated here must have inhabited such an area during the period of evolution, and species with a preference for open savannas may have come in later, or may have been very few in number until within historical times. The extensive area of moist deciduous and tropical rain forests shown by you on the forest-distribution map, all point to this hypothesis."

[2] Oviedo, writing of the early years of 1500 concerning animals, trees, and the like in Porto Rico, stated that they did not differ from those already described in the "Isla Espanola." The North American and West Indian Gazetteer (1778) states that "the sides of the hills are covered with trees of various kinds, proper for building ships and other useful purposes." Fray Iñigo (1788), besides mentioning the superior and much greater variety of timber trees in the uplands, also states that many trees are found in the southern part of the island as well, although conditions there were much more arid and less fertile than on the north coast. In the account of the capture of San Juan by the Earl of Cumberland (1597), the small island on which San Juan is situated is described as "for the most woods." Continuing, the Luquillo region and the interior generally are described as follows: "The valleys are much wooded but in very many places interlaced with goodly large Playnes and spacious Lawnes. The woods are not only underlings but timber trees of goodly tallnesse and stature, fit for the building of ships and of every part of them." According to Herrera, (English translation, 1726), "The Island * * * has much good pasture for cattle, which decreases, by reason of the great number of trees increasing * * * so that the Island is overgrown with Woods." Flinter (1834), speaking of the surroundings of Guayama, says that 5 or 6 years previously it was merely "an immense tract of woodland." He also says: "The forests which cover the mountains of Porto Rico are filled with timber of the best quality for the construction of ships and houses. In some parts of the coast from the very improvident manner in which wood has been cut down and burned for charcoal and much left to rot on the ground, timber is getting scarce; but in the interior there is yet an abundance of superior timber." In 1830 timber to the value of $21,000 was exported through the customhouses of this island, exclusively of what is shipped clandestinely." This work in particular has numerous other references to the extent and luxuriance of the forest growth on the island. Finally Barrett (1902) tells us that "more than half a century ago the Spanish planters of the island began clearing the interior districts for coffee and tobacco culture. There being no good roads and but little demand for timber, the trees were burned where they fell; hundreds of thousands of dollars' worth of lumber and cabinet woods were thus destroyed."

[3] See Bibliography.

of the Luquillo. The forests of Porto Rico differ from those of the other islands chiefly in the absence of any pine growth. Santo Domingo, now least changed from its original pre-Columbian condition, still has fully 85 per cent of its land area under virgin forest. Probably at least 50 per cent of Cuba is wooded, not far from 30 per cent being virgin forest. Santo Domingo has a population density of 33 per square mile, Cuba 46, and Porto Rico 325. There is little wonder that Porto Rico is nearly deforested.

The assertion of a completely forested Porto Rico does not mean that there were no open lands at the time of Columbus's first visit. There were in fact even then more or less extensive clearings surrounding each native village. These clearings were continued and extended by the white settlers that they might cultivate sugar cane, ginger,

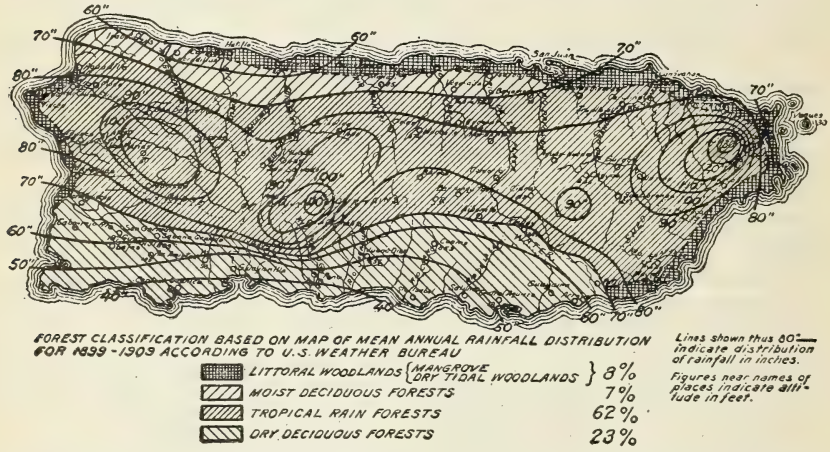
FOREST CLASSIFICATION BASED ON MAP OF MEAN ANNUAL RAINFALL DISTRIBUTION FOR 1899-1903 ACCORDING TO U.S. WEATHER BUREAU
LITTORAL WOODLANDS (MANGROVE, DRY TIDAL WOODLANDS) 8%
MOIST DECIDUOUS FORESTS 7%
TROPICAL RAIN FORESTS 62%
DRY DECIDUOUS FORESTS 23%
Lines shown thus 80" indicate distribution of rainfall in inches.
Figures near names of places indicate altitude in feet.

FIG. 6.—Porto Rico. Pre-Columbian distribution of forest formations. (Diagrammatically shown.)

and other crops, and provide pasture for cattle brought from Spain. The clearing proceeded more rapidly on the north than on the south side of the island and was likewise confined for the most part to the lowland. Until nearly the middle of the nineteenth century the interior mountain forests were probably but little disturbed. The gradual ascendency of the coffee industry over that of sugar and tobacco, which culminated during the closing years of Spanish rule, undoubtedly strongly influenced the development of the interior.

Of the once extensive virgin tropical forest there now remain only isolated remnants scattered over the island in its most mountainous parts. The best known and most famous of these, and the largest as well, still covers a considerable portion of the Luquillo Range. While it has for upward of half a century been gradually encroached upon, progress has been slow. The abruptness of the slopes and the size of the trees have made timber exploitation by native methods

very difficult. Exposure to excessive and constant strong winds, abnormally heavy precipitation, and extended cloudiness have prevented the region from being invaded to a greater extent by the coffee planter. These same conditions also have doubtless not been entirely to the liking of the "conuco" farmer, at least so long as there were other lands available. This tract has an aggregate acreage of between 35,000 and 40,000 acres, including several thousand acres of low gnarled growth on its summits and wind-swept slopes. A part at least of this forested area is in government ownership.

Other tracts, more or less limited in extent, of virgin or only lightly culled high forest are to be found near Maricao, in a deep ravine at the headwaters of the Rio Maricao, near Jayuya, on Mount Morales and Mount Mandios;[1] near "La Isolina" on the Rio Limon between Utuado and Ciales,[2] and in Barrio Angeles between Lares and Utuado on the Rio Angeles.[3] The aggregate of all such areas, aside from the Luquillo, is believed to be well within 5,000 acres, making the total area of high forest scarcely 2 per cent of the total land area.

There are besides about 400,000 acres assessed as "timber and brush lands" and a few thousand acres additional classified as swamps and largely under mangrove. Of the timber and brush areas the bulk will be found in the southern, southeastern, and southwestern parts of the island, on the dry limestone hills and other land of little or no agricultural value. On the north side such areas will be found almost exclusively on the thin-soiled, conical limestone hills.

Thus, including virgin forests and all, the total wooded area amounts to approximately 20 per cent of the total land area. In all probability not more than from one-fourth to two-fifths of this area (5 to 8 per cent of total land area) is now under forest capable of yielding a wood product other than charcoal and fuel wood. If now there be added the 168,000 acres in coffee plantations and the 6,500 acres under coconut palms which are in effect artificial forests, the grand total of all lands under a forest or brush cover will approximate 600,000 acres, or 27 per cent of the insular domain.

FOREST FORMATIONS.

The term "virgin forest" was formerly applied by travelers in the Tropics exclusively to the evergreen forest found in constantly humid regions or those of similar luxuriance along the watercourses; in other words, to the tropical forest jungle. Not only are these not

[1] Reported by N. L. Britton in Journal N. Y. Botanical Garden, May, 1906.

[2] Reported to the writer personally by the director of the U. S. Weather Bureau at San Juan and by L. M. Underwood in Journal N. Y. Botanical Garden, Nov., 1901.

[3] Reported personally to the writer by the lieutenant of police at Utuado.

the only virgin forests in the Tropics, but in many cases they themselves may not be virgin at all, but second growth.[1]

Because the rain-forest—the jungle—presents not only unusual but often spectacular features which make a most direct appeal to the interest and a most lasting impression on the mind, it has come to typify the tropical forest in general. Yet it would be scarcely less misleading to represent the mammoth redwoods or the giant fir and cedar forests of our Pacific coast, or even the magnificently diversified hardwood forests of the Appalachian region, as being the typical and prevailing forest growth of temperate North America.

In its original forested condition Porto Rico undoubtedly presented a diversity of forest formations unexcelled in any other similar area in the West Indian Tropics. Of the general types found throughout the Tropics, only those were impossible of occurrence which result from extremes of altitude and of drought. Thus alpine and desert elements were unquestionably never developed here. The various formations in the order of their occurrence from the coast toward the interior are as follows: Littoral woodlands, moist deciduous forests,[2] and tropical rain-forests on the north or humid side, and the dry deciduous forest[3] on the south or semiarid side.

The distribution of these formations was, of course, not so simple as might be implied by the last sentence, there being more or less overlapping. Remnants of these formations are, with few exceptions, still to be found in the out-of-the-way places of the island, although their original balance and relative importance have been very much modified.[4]

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[1] This is very interestingly brought out in Cook's "Vegetation Affected by Agriculture in Central America" (Bureau of Plant Industry Bulletin 145), from which the following is quoted: "Many localities which are now occupied by apparently virgin forests are shown by archæological remains to be regions of reforestation. Thus in the Senahu-Cahabon district of Alta Vera Paz, relics of two or three very different types of primitive civilizations indicate that as many ancient populations have occupied successively the same areas which are now being cleared anew by the coffee planters as though for the first time.

"It does not yet appear that any considerable region of forest has been explored in Central America without finding similar evidence that the present forests are not truly virgin growth. * * *"

And again, speaking of the evidence of antiquity as exemplified by the crumbling of large earthenware pots of an earlier civilization, he continues: "We can not know how long it has taken the pottery to crumble, but we can at least contrast the condition of these decayed pots with other pieces of pottery placed in caves of the same district in later prehistoric ages, which will appear fresh and new, as though recently burned. And yet the bones beside these apparently new pots have also crumbled nearly to dust, and there has been time for the surrounding country to be occupied with old forests of hardwood trees, like true virgin growth." He also mentions terracing of the land as showing that agriculture was formerly extensively practiced and notes the presence of a type of terrace evidently designed "to hold drainage water and prevent erosion * * * being frequently met with in the heavily forested region of eastern Guatemala."

[2] Called "monsoon forest" by Schimper.

[3] Also called "thorn-woodland" by Schimper and "chaparral" by Harshberger.

[4] The natural balance and relative importance of the different formations as given by Woodward for Santo Domingo on a percentage basis for the total forested area is as follows: Wet hardwood type (which includes the "moist deciduous" and "tropical rain" forests of the above classification), 58 per cent; dry hardwood type ("littoral woodlands" and "dry deciduous" forests), 28 per cent; pine type (lacking entirely in Porto Rico, but occurring on a similar site to the "dry deciduous" forest), 14 per cent.

F-19758A

VIRGIN STAND OF TABANUCO. MOIST DECIDUOUS FOREST FORMATION NEAR LA ISOLINA (ARECIBO).

Littoral Woodlands.

The littoral woodlands, although most characteristically developed on the humid side of the island, have certain strong resemblances to the dry deciduous forests of the south coast, the one merging into, giving way to, or overlapping the other at their points of contact. Both formations are forced to struggle continually against the effects of drought. In the case of the littoral woodlands this is occasioned largely by porous and saline soil conditions accentuated by certain adverse climatic factors, strong wind particularly. With the dry deciduous forests, the determining factor is deficient rainfall, to which adverse soil conditions give added effect. The littoral woodland formation presents two distinct types, namely, the mangrove or wet tidal woodlands below high-water mark and the dry tidal woodlands above high-water mark.

THE MANGROVE.

The mangrove, or wet tidal woodland, is a distinctly tropical formation. Though unable to withstand unbroken wave action on the open coast, it readily establishes itself in the shallow brackish waters of protected embayments, creeks, and lagoons, where, under favorable climatic conditions, it forms dense, almost impenetrable thickets. The Porto Rican mangrove rarely attains a height of over 10 feet above the water, though elsewhere it reaches very respectable forest dimensions. Even in the more or less protected lagoons it is generally exposed to the strong trade winds, which accounts in part for its low stature, while its popularity for fuel and other uses undoubtedly prevents it from attaining its full size.

The sea, receding at low tide as far as the edge of what seems at high tide a veritable forest rising from the waters, reveals a tangled mass of stiltlike roots anchoring the trees to the blue-black muck along the shore. With every tide new soil material is deposited among the mangrove, which keeps gradually pushing out to occupy new ground, through its remarkable mode of reproduction. The fruit when it reaches maturity remains attached to the parent plant, the seed embryo all the while continuing its development into a new young plant. Having attained a certain size this plant releases itself, falls into the soft mud, strikes root, and becomes firmly fixed within a few hours.

The mangrove in general attains its most favorable development where the humidity is high, precipitation abundant, and an intermittent cloudiness prevails. Its distribution accordingly coincides in general with that of the rain-forest.[1] Thus the mangrove in Porto Rico is most abundant along the north and east coasts, is much more restricted on the west coast, and is only sparingly and locally de-

[1] See Schimper's Plant Geography.

veloped on the south. Here it occurs chiefly at the mouths of the larger rivers, where a dilution of the sea water enables it to grow in spite of the otherwise unfavorable climatic conditions.

Three of the four common species of the western mangrove,[1] of tropical American and West African coasts, occur in Porto Rico. One is known locally as mangle colorado (122),[2] and the other two as mangle blanco (or bobo) (127 and 157). Mangle colorado occupies the outer exposed edge of the formation, while mangle blanco occur, the one (*Avicennia*) intermediately and the other (*Laguncularia*) at the inner boundary. The latter often forms pure mangrove. Other species associated with this formation are mangle botón (125) and mangle prieto (unidentified), small trees, usually under 20 feet in height. On drier islets within the formation other species may occur, and likewise on the inner side, where by a gradual transition the mangrove gives way to the dry tidal woodlands. Epiphytes, so characteristic of other tropical forest formations, are scarce and are confined to a few bromeliads and lichens.

The mangrove is of considerable economic importance, furnishing fuel, especially to the bakeries, from its limbs and branches, and posts and house piling from the submerged parts. For these latter uses it is very highly prized because of its resistance to decay and to the attack of the white ant. The bark contains a tanning material and a dye, though to what extent it is used locally is not known.

Practically all of this mangrove land belongs to the insular government. In a few places, as in parts of San Juan Harbor, the mangrove will have to be cleared away to make room for needed water-front improvements. Other tracts might perhaps be converted into arable land by drainage. Most of these lands, however, should be retained by the government and managed under approved forestry principles as public wood reserves.[3] They would constitute a most valuable

[1] The fourth species, *Avicennia tomentosa* Jacq., is not identified from Porto Rico. The eastern mangrove is much richer in forms. Thus in Farther India and the Malay Archipelago, where it shows its greatest diversity, it consists of Rhizophoraceæ (9 species), Lythraceæ (3 species), Combretaceæ, Meliaceæ, and Verbenaceæ (2 species each), Myrisinaceæ, Rubiaceæ, Anthraceæ, and Palmæ (1 species each); 22 species in all, according to Schimper.

[2] The figures in parenthesis refer to the descriptive list (Appendix I).

[3] In many eastern tropical countries the immense value of these swamp areas is now fully appreciated. In the Federated Malay States the mangrove is classed as "one of the two important divisions of the commercial Malay forests." In 1904 the development of the mangrove areas as a source of fuel supply for the Government railways and for general public consumption was begun under sytematically prepared working plans. (Burns-Murdock, A. M. "Notes from the Federated Malay States," Indian Forester, Vol. XXX, No. 10, Oct., 1904).

In the Philippines the mangrove is regarded as "in many respects one of the most valuable forest assets of the islands." The bureau is now engaged in selecting the most important commercial areas and thoroughly investigating their possibilities. (Director of Forestry of the Philippine Islands, annual report for fiscal year ending June 30, 1912).

The mangrove is managed on a short rotation under a clean-cutting system, making it a simple crop to handle. As practiced by the Philippine natives in growing "bacauan" (includes several mangrove species) for cordwood, the seed is collected and sown at a cost of about $2.50 an acre. Then without any further attention the crop at the end of six years is ripe to cut, and brings as high as $20 an acre on the stump, according to W. D. Sterrett, formerly forester of Bataan Province, Philippine Bureau of Forestry.

source of cheap wood supply for general use, where it is most needed, in and around the coast cities, and would yield a considerable income to the government through the sale of the wood and other products.

Dry Tidal Woodlands.

The dry tidal woodland is confined to the sandy or gravelly soil areas skirting the open shore or lying directly behind the mangrove type in the sheltered embayments. While its former extent and distribution can be reasonably well defined, its original composition can only vaguely be surmised. Its sole representatives at the present time are groves of coconut palm; the dry deciduous forests of more or less strongly modified composition, due to the intermingling of typical shore species such as uvero (14) and others; and the open shrub growths of these latter species alone.[1] The coconut palm type will be considered in more detail elsewhere as will also the dry deciduous forests.

EASTERN LITTORAL WOODLANDS.

The littoral woodland is readily distinguishable in the East Indies and adjacent continental areas, where it has been more or less carefully studied and described, particularly in Java. At present two of the most conspicuous trees planted in and around San Juan are from this formation, the almendra (123) and the more recently introduced *Casuarina equisetifolia* (Australian beefwood). Other characteristic tree species of the eastern littoral are *Cycas circinalis*, *Pandanus* (several species), *Calophyllum inophyllum* (Guttiferæ), *Cerbera odollam* (Apocynaceæ), *Hibiscus tiliaceus* and *Thespesia populnea* ("Emmajagua" and "Santa Maria," respectively, of Porto Rico), (Malvaceæ), *Hernandia peltata* (Hernandiaceæ), *Heritiera littoralis* (Sterculiaceæ), and various Leguminosæ (*Inocarpus edulis*, species of *Albizzia*, *Cynometra*, *Erythrina*, *Pongamia glabra*, *Sophora tomentosa*, and others).

Moist Deciduous Forests.

Transitional between the littoral woodlands and the rain-forest formations in all probability originally occurred the moist deciduous forests. On the north side of the island this formation occupied the limestone belt lying between the coast and the central mountains and extending from San Juan west to Aguadilla. On the south side it very likely was confined largely to the middle and upper south slopes of the central mountain clay soils. Little forest growth of any sort, however, now remains on these areas. Particularly is this true of the south slopes of the Cordillera Central, where the trees are scattered

[1] The failure of plant geographers to recognize and segregate this information in the West Indies is probably due to the fact that the sites where this formation had formerly attained most characteristic development have long been exclusively appropriated by man for the cultivation of the coconut palm. Elsewhere, possibly by cutting and the more aggressive competition on the part of the closely allied dry deciduous formation, its composition has been so modified as to make these two formations scarcely distinguishable one from the other.

singly or in small clumps on the open grass slopes and in narrow strips along the watercourses.[1]

On the north side of the divide the virgin forest area near La Isolina constitutes a possible remnant of this moist deciduous forest. Here the tabanuco (69) is a prominent feature in the stand. Elsewhere, as on the limestone uplands north of Lares, the moralon (15), aceitillo (66), capa blanca (155), limoncillo (129), granadillo (124), and other large trees are reported formerly to have been common. Here, too, we should expect to have found the caoba (72). Some of the rich forest growth was cut for fuel and building material, but much of it is reported to have been cleared away by the "conuco." The land here is now merely open grass land.

In the "pepino" or "pit" country a homogeneous forest cover is impossible. In the pit bottoms, which are now largely under cultivation to bananas and coffee, a high forest cover of the moist deciduous type undoubtedly prevailed. The steep sides and summits of these hills in many places even to-day present a well-wooded appearance, though the occurrence of an occasional fair-sized tree in some particularly inaccessible place throws into contrast the main cover, which is low and bushy and much like that of the dry deciduous formation. Undoubtedly these rough crags have been cut over in the past, but owing to their absolute uselessness for cultivation they have escaped being burned over.

EASTERN MOIST DECIDUOUS FORESTS.

The moist deciduous formation of India and Ceylon contains most of their valuable timber trees, such as teak (*Tectona grandis*), sal (*Shorea robusta*), satinwood (*Chloroxylon swietenia*), ebony (*Diospyros ebenum*), trincomalie-wood (*Berrya ammonilla*), etc. Near the coast a number of evergreen trees are found in mixture, as *Mimusops hexandra*, *M. elengi*, species of *Memecylon*, *Pleurostylia wightii*, *Nephelium*, *Sapindus*, etc. In Australia this is a savanna forest and consists largely of acacias and eucalypts.

In South America this formation more closely resembles the savanna than the rain-forest type and is known locally as "campos," "llanos," "caatinga," etc. It is important economically because of the rubber-yielding trees which grow within it, the "ceara-rubber" tree or "manisoba" (*Manihot glaziovii*, *M. dichotoma*, *M. piyauhensis*, etc.) and the "para-rubber" tree (*Hevea braziliensis*), the former in the open savanna forests of northern Brazil and the latter in the basin of the Amazon.

Tropical Rain-Forests.

Forest vegetation culminates in density and luxuriance of growth in the rain-forests, the most extensive of the original forest forms,

[1] *Fringing-forests.*—Closely allied to both the moist deciduous and rain-forest formations are the appropriately named fringing-forests or gallery-forests, mentioned, respectively, by Schimper and Broun, dense tropical forests of unusual luxuriance occupying the banks of streams and rivers within dry regions. They owe their luxuriance to the abundant moisture in the soil. Their extent back from the river thus depends on the quantity and constancy of the stream flow and the modifying influence it is able to exert on the adjacent soils. Such was the type of forest in all probability that Flinter (see note, p. 21) referred to particularly as occurring in the vicinity of Guayama. Remnants of these forests are to be seen to-day, in many places bordering the south coast streams where they have not been destroyed to make way for cane growing. The contrast between them and adjacent forests of the dry deciduous formation is very striking. The rich forests of the Amazon are to a considerable extent of this type.

F–19760A

FIG. 1.—SECOND GROWTH MOIST DECIDUOUS FOREST BETWEEN ISABELLA AND QUEBRADILLAS.

F–19757A

FIG. 2.—"FRINGING FORESTS" WHICH SKIRT THE WATER COURSES THROUGH THE SEMIARID SOUTH COAST REGIONS, YET EXHIBIT MANY OF THE CHARACTERISTICS OF THE MOIST DECIDUOUS AND RAIN-FOREST FORMATIONS.

formerly covering the entire central uplands of the island, including the valley plains of the large rivers, and reaching quite to the coast on the east and west ends of the island. They undoubtedly attained their richest development in the bottoms and sheltered slopes of the larger river basins, but these being the most productive and the most accessible, were the first to be stripped of their forest wealth. There is little doubt that the greater part of this splendid natural resource was never utilized, but was felled and burned. What remains is but a poor example of this once magnificent forest domain.

The rain-forest from a distance looks not unlike our northern deciduous forests, except where groups of palms or the yagruma (136) occur in mixture with the broadleaf trees or where the bright-colored blossoms of some flowering tree or epiphytic plant perched high in the crown of its towering host interrupts the green of the background. The foliage presents a variety of the duller and more somber greens, but lacks entirely the fresh new green of the spring foliage in the north. The crown level is also less regular than that of our northern woods. Individual trees with wide-spreading crowns tower far above the general level, the whole presenting a jagged and haphazard appearance. On closer inspection a further contrast is apparent in the greater number of trees with compound leaves, such as cedro (71), guaraguao (74), and many others. The crown of the average tree of the rain-forest is very much less branched than that of the northern deciduous forest tree, there being but few main branches, themselves only slightly branched, so that the tree has a very irregular appearance. The leaves are highly diversified, not infrequently glossy, and of a fine leathery texture, and though pinnate seldom finely so or felted with hairs. They are usually set obliquely with relation to the direct overhead light and often aggregated in tufts at the ends of long, bare branches.

The interior of the rain-forest is still more striking in contrast and more haphazard in appearance than its exterior. The growing space appears to be unequally utilized; in places the stand is very dense and is matted and tangled with a profusion of thick-stemmed woody lianas and countless epiphytic orchids, bromeliads, ferns, and even trees, covering every branch and extending to the tops of the tallest trees; in other places the cover is very much broken, permitting great patches of sunlight to reach the ground. In the denser parts the ground is very sparsely covered, while in the openings palms and other young trees, or a most detestable cutting grass, strive to occupy the ground. True shrubs are inconspicuous, most of the undergrowth being of the same species as the main forest cover.

The soil in the forest is not only in large measure bare of herbaceous growth, but it is very poor in vegetable mold. It is simply blackened by the decaying vegetable matter. Humus, as we know it in the

broadleaf forest of the the north, is very rare. Decomposition is extremely rapid under the influence of tropical heat and great humidity, and these, together with more gradual leaf fall, extending over the entire year, prevent the accumulation of litter. Then, too, the torrential rains wash much of it off the steep slopes almost as rapidly as it is formed.

As to the trees themselves there is almost infinite assortment of kinds, sizes, and forms. One of the most striking features is the large number of light-colored, smooth-barked species resembling in appearance our northern beech.[1] Then, too, the trunks of the trees forming the main crown cover are very characteristic, being for the most part of very unequal thickness, and usually more slender[2] than those in the virgin forests of the Temperate Zone. Large trees up to 5 feet in diameter above the root flare, however, are not lacking even to-day in the Luquillo. There are, besides, many trees, tabanuco (69) for instance, with a much-buttressed base formed by planklike outgrowth from the trunk and the uppermost roots.

There is a striking lack of uniformity in association and in distribution of species. The reasons for this are the vast number of species,[3] the combination of accidental association that such a number makes possible, and the absence of any considerable modifying soil or other conditions tending to form fixed associations within the broader and more uniform climatic one.[4] The presence or absence of a tree, particularly one of the more valuable kinds, like cedro, appears to be a matter largely of chance. The really valuable trees seem almost hopelessly in the minority, while the inferior species are so numerous as to impress one with the apparent worthlessness of the forest. Unquestionably many of the so-called worthless woods are unjustly

[1] According to Schimper this is owing to the prejudicial effect of humidity on the formation of cork, the bark thus remaining poorly developed. The formation of bark is often so poor that moderately large trees show green, owing to the chlorophyll of the cortical layer being visible through it. There is, nevertheless, considerable individuality to the bark of different trees; some have thin flaky and scaly bark, as in Myrtaceæ, or a green surface, as in some Leguminoseæ; others, again, are armed with spines or corky warts, while still others exude resins when wounded.

[2] This, according to Schimper, is a distinguishing characteristic of the virgin tropical forest. Woodward, too, discussing the rain-forest in Santo Domingo, states that while trees over 5 feet in diameter and 100 feet high are occasionally found, the average is far below these figures.

[3] Gifford and Barrett in their "Trees of the Luquillo Region" (appendix to Bulletin 54, Forest Service, "The Luquillo Forest Reserve, Porto Rico") compiled a classified description of something over 100 identified species and enumerated besides the common names of nearly 100 more.

[4] That the condition is not peculiar to Porto Rico, as many believe, and that, except in extent, the rain forests of the Luquillo do not essentially differ from the other Antillean forests, the following will show: Woodward remarks that in the virgin rain-forests of Santo Domingo two caoba (mahogany) trees to the acre constitute a good stand. Fernow, likewise, is speaking of the virgin forests of the Sierra Maestra, Cuba, remarks that it was most puzzling to discover a law of distribution. "After many days cruising," he says, "over canyon, slope, and ridge one finds in identically the same kind of locality a new species, a single tree or group never to be seen again in further cruisings. Nearly 400 miles had been traveled before the first group of ebony was met." He further states that "the openness of the main stand may be judged from the statement that as developed by some 1,200 acres of sample area, less than 1.4 trees of commercial size per acre were found. When it is considered that over 100 species participate in making up this stand the difficulties of a commercial or even a botanical survey will be realized."

discriminated against because their good qualities are commercially unknown.

There is an almost complete absence of species having a gregarious habit, the tabanuco (69)[1] and palma de sierra (3) being the chief exceptions.

RAIN FORESTS OF THE LUQUILLO.

The entire forested area in the Sierra de Luquillo is within the rain-forest belt. The situation is, however, a generally unfavorable one as compared with other areas of abundant rainfall by virtue of its unshielded exposure to the full force of the trade winds, so that the forests here represent rather the minimum tropical rain-forest development.

The main stand of the typical rain-forest development previously described covers probably somewhat more than half of the mountain area. Its four leading species are tabanuco (69), guaraguao (74), laurel sabino (17), and ausubo (141), in the order of their numerical importance. Largely because it has always been in great demand among the natives for all manner of uses, the ausubo is now quite scarce. Cedro (71), too, is only occasionally to be found here. It is doubtful if there was ever more than a scattering of caoba (72), because of its preference for a slightly less humid site. While these forests are usually considered to be undisturbed original growth, such is not, strictly speaking, the case, for cedro and others of the more valuable woods have been taken out a tree at a time by a gradual culling process extending over many years.[2]

Two subordinate types within the tropical rain-forest belt of the Luquillo are the "hurricane hardwood" and "sierra palm" types. The former, occupying the places of greatest exposure, the ridge summits and the easterly slopes above 2,500 feet elevation particularly, is a low, gnarled, and stunted tree growth, mainly of the inferior species.[3] Scarcely 25 feet high, the stands are in most places very dense and the limbs of the trees interlace and are covered with water-laden moss. For days at a time this type may be continuously bathed in

[1] See Plate III.

[2] There is authentic information concerning one cedro cut within the last 6 years from the south side of the range, the stump of which yet remains and measures 18 feet in circumference (5½ feet in diameter). Several attempts are reported to have been made before a purchaser could be found for this tree because of its size and the difficulty of felling it and moving it away with the ordinary means at hand. Another, still standing at the present time, measures 25 feet 5 inches in circumference.

[3] An instance called to the attention of the writer relative to one of the secondary peaks visited by him in 1912 toward the south side of the range (elevation 3,000 feet) suggests the possibility of the hurricane of 1898 being at least a contributory cause of the low cover found on these exposed sites and led to the selection of the name "hurricane hardwood" type to designate this growth. An American resident said that at the time she took up residence there in the winter of 1899–1900 this peak was stripped entirely bare of all vegetation and that it remained so for 2 to 3 years afterward. Gradually it showed patches of green and eventually became entirely covered. The present stand is a dense young growth of yagrumo, palma de sierra, and other of the poorer quality hardwoods. It may be significant that Dr. George Eggar, quoted by Hill, does not remark on the presence of such a growth at the time of his exploration of El Yunque in 1887, when a more normal growth may have been present.

moisture by the clouds, which leave the summits of these mountains only intermittently during a considerable part of the year. Although commercially of no value whatever, this scrub growth is tremendously important in protecting the exposed slopes from erosion.

Palma de sierra occurs throughout the uplands and in places in sufficient numbers to dominate the stand, forming what may be called the "sierra palm" type. This occurs alike on the exposed easterly slope and in the protected basins, often where the land is rough and stony and windfall most likely. Consequently it is quite likely a temporary type brought about through windstorm or other accident to the original stand. In the protected localities the associated species comprising the more valuable hardwoods are numerous and usually well developed, so that the growth is not without commercial value and future possibilities. At present these two types—the "hurricane hardwood" type, of no commercial value, and the "sierra palm" type, only partially merchantable—aggregate about half the forested area and dominate the mountain tops and exposed uplands of the Luquillo.

RAIN FORESTS OF THE EASTERN TROPICS.

Many valuable species, including the great natural order of the Dipterocarpaceae, find their homes in the luxuriant rain forests of the Philippines, the other East Indies, and the neighboring mainland. The different trees of this order by the variety of their woods, varying from those resembling our soft pine to the heaviest and hardest cabinet woods, are suitable to almost every conceivable use. Several are gregarious and form more or less pure forests, as for instance the eng (*Dipterocarpus tuberculatus*) of Burma, the hora (*D. zeylanicus*) of Ceylon, also *Vatica obscura* and *V. roxburghiana* of Ceylon. Other forests are dominated by members of this natural order. Thus, in the moister forests of Ceylon there are portions composed almost entirely of different species of *Doona*, freely mixed with *Dipterocarpus*, *Shorea*, *Stemonoporus*, *Hopea*, and along rocky gullies *Vateria*. In the Philippines 70 per cent of the total stand of timber is said to consist of trees of this family. Economically, therefore, this natural order is a very important one, for besides its major timber products it yields many valuable minor products, as camphor from *Dryabalanops aromatica*, gum resin and dammar from several species of *Shorea*, *Doona*, and *Dipterocarpus*, and so on. The tribe of the bamboos also finds in these wet tropical forests its greatest development.

Besides the above there are many species of value both in the East Indies and on the mainland, in Africa, and tropical Australia and Queensland. This region, not to mention the resources of tropical America, affords opportunity for almost infinite selection for introduction by which to repair any deficiencies in commercial qualities of the Porto Rican tree flora.

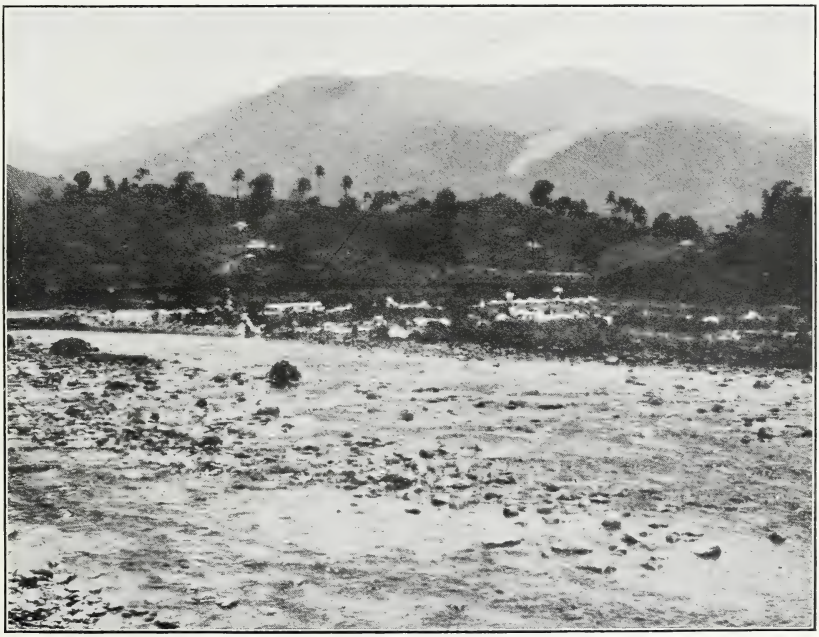
Dry Deciduous Forests.

The dry deciduous formation known in others of the West Indies and in Central America and Mexico as chaparral was in pre-Columbian times the second most extensive. Typically a formation of the semiarid region, it dominated the south coast lands, foothills, plains, and lower slopes of the central mountains from Patillas to Hormin-

F–19762A

FIG. 1.—SOUTH SLOPES OF LUQUILLO MOUNTAINS.

Cleared almost to the summit. "La Florida," the fruit farm in the foreground, is in the southeast corner of the Forest on the Rio Blanco. The elevation here is about 100 feet while the peak in the background, scarcely 2 miles distant, is 3,000 feet above sea level.



F–19759A

FIG. 2.—LUQUILLO MOUNTAINS FROM THE NORTH.

Valley of Rio Maneyes in foreground. El Yunque, elevation 3,483 feet, at the right. Smoke in the middle ground probably from the burning of cane refuse after the harvest.

LOQUILLO NATIONAL FOREST.

F–19761A

FIG. 1.—THE WOODED SUMMIT OF EL YUNQUE, FROM LAS PIEDRAS, A ROCK BALD CLOSE TO THE SUMMIT.

Note the sierra palms mixed groupwise in the hardwood stand.

F–20022A

FIG. 2.—VIEW TO THE EAST FROM EL YUNQUE, SHOWING THE OUTLINE OF THE EAST COAST FROM CAPE SAN JUAN SOUTHWARD.

The greater part of the forested tract in the foreground belongs to the insular government Note the smoke in the right center from a charcoal pit or conuco clearing, doubtless.

LUQUILLO NATIONAL FOREST.

gueros (not far from one-fourth the area of the island), as well as Vieques, Culebra, Mona, and the other outlying islands. It still occupies to a large extent the thin-soiled, rugged limestone hills, and has extended itself on the poorer soils of the north coast, principally at the expense of the dry tidal woodlands and moist deciduous forests of the limestone formation. In both situations, however, its composition is somewhat modified through the persistence of some of the more tenacious species of the formations displaced. On the deeper soils of the more gentle slopes and plains of the south coast country back from the streams the dry deciduous forest has in large measure been displaced by agriculture—nomadic agriculture originally, which burned and destroyed the forests and planted on their ashes. This land once cleared and then abandoned reverts to a forest growth with extreme difficulty, if at all. The open grass-covered savanna is the general result, with but here and there a tree where a particularly large individual escaped destruction or local conditions favored its getting a start and enabled it to compete with the turf. A transitional form of forest which might be called the "savanna forest" may occasionally be met with where the open savanna and the true forest join. Here the most hardy and drought-resisting varieties of trees form open stands in the grassy waste.

Although the dry deciduous forests vary from the closed chaparral form to that of the open savanna, they have certain well-defined characteristics. They are more or less leafless during the several months of the dry season and have a generally brown and parched appearance, evergreen trees such as the pajuil (86) being rare. Grass and other herbaceous growth under and between the trees is almost always present. Lianas are small and slender and absent entirely from the more open parts of the formation. *Tillandsia* (Spanish moss) festoons many of the trees and is the most conspicuous and most common among the epiphytes, here known collectively as piñuelas. There are a few other bromeliads and an occasional orchid. Exceedingly characteristic also of the formation are the pitajaya (120) and tuna (120), the tree cactuses and opuntias.

The trees themselves, rarely over 30 feet high, are short and thick-bodied, have a thick, fissured bark and a light, open, feathery crown which in the open is very apt to be flat-topped and umbrella-shaped, or to have its branches and foliage arranged in tiers. Leguminous trees with thorny branches and fine, usually firm-textured compound leaves, are particularly characteristic. Among the more common of these are guava (36), guama (37), tachuelo (54), cobana negra (44), algarrobo (45), campeche (50), moca (58), and many others. The wood of many of these trees is extremely heavy, hard, and durable.

Among nonleguminous trees are guayacan (60), jobo (87), almacigo (70), tea (64), guano (107), ucar (126), quebra hacha (94), and a host of others. The ceiba (105) is a conspicuous tree of the open savanna.[1]

Old Field Growth.

The old field type is an incidental and temporary one, in many places in a formative state. It varies considerably from place to place, the designation having been selected for all situations where there is a manifest tendency of land formerly cultivated and now more or less covered with grass to revert to forest. This tendency is at present general except on some dry south coast situations. The palm-studded hills most strikingly display this effort of nature to restore the balance. Palms, through their ability to grow in dry situations, are to that extent admirably adapted to assume this pioneer rôle. Their poor reproductive capacity, with the possible exception of the palma de sierra, renders them less aggressive than they otherwise might be. Another conspicuous old field pioneer growth is the poma rosa (133). The "poma rosa" type is very conspicuously developed on the uplands between Cayey and Guayama and in the vicinity of Aibonito. Natural reforestation even by this apparently more aggressive tree is slow. This may be due in part to a practice of successive clearings rotating this volunteer wood growth with intermittent cropping to rice, beans, and the like. Cutting for charcoal and for other uses also undoubtedly interferes.

Cultural Forests.

A description of the forests of Porto Rico would be incomplete without mention of its cultural forests. They not only cover a considerable acreage and are uniformly developed and kept up, but they are the most conspicuous forest growth on the island taken as a whole.

COCONUT PALM GROVES.

The palma de coco (4), or simply coco, is of uncertain origin,[2] but, however that may be, it has by one means or another been distributed

[1] One especially notable tree of this species near Ponce measures, according to Cook and Collins, 36 meters (118 feet) in circumference 4 feet from the ground, following the sinuosities of the trunk. Herrera says of the ceiba that it "has so great a shade that a strong man can not throw a stone across it. The tree is so big that a carpenter whose name was Pantaleo made a chapel of one hollowed out, being so thick that 15 men holding hand in hand can not grasp it."

[2] Cook ("The Origin and Distribution of the Coconut Palm," by O. F. Cook, Contributions from the National Herbarium, Vol. VII, No. 2) scouts the currently accepted opinion that this species originated in the Indian Archipelago and concludes: "The original habitat of the coco palm is to be sought in South America, the home of all the other species of cocos and of most of the closely related genera." He likewise controverts the common notion that the coconut originated as a strand plant, that the thick husk is an adaptation to enable the dispersal of seed by ocean currents, and that even the seeds thus transported have the ability to germinate and maintain themselves in competition with the other strand vegetation. "The coco palm," he says, "is unable to maintain an existence when subjected to the competition of the wild vegetation of tropical shores and forests." And, finally, "the idea (that they can not thrive in undisturbed nature) is recognized in the Cingalese proverb, 'The coconut will not grow out of the sound of the sea or of human voices,' and in the belief held among the same people that the trees will not thrive unless 'you walk and talk amongst them.'"

widely throughout the maritime regions of the Tropics. How long it has been cultivated can only be surmised, but sufficiently long at any rate for the development of many varieties. These varietal forms are mostly found in the islands of the Indian Ocean and the Malay region, little attention having been given to improvement by selection in tropical America.

These groves line the shore in many places and, when well cared for, are a profitable source of income. As yet the nut is the only product exported from the island.[1] There were, according to the 1912 tax assessment list, 6,556 acres of land under coconuts, having a total value of $663,710, and an average value per acre of $101.24 (maximum $269.45 in Anasco and minimum $24 in Comerio).

THE COFFEE FORESTS.

Coffee will grow without difficulty at sea level, but it thrives best in the upland district above 2,000 feet elevation. Because of this adaptability to soil and climatic conditions more or less unfavorable to crops requiring clean cultivation, its extension throughout the uplands of the interior was readily accomplished. Whether or not the coffee bush was ever cultivated in the open here, as in Brazil, it is now considered necessary to grow it under shade.[2] While areas of virgin forest were available these were used for coffee culture, the overwood being thinned and the underwood cleaned out and replaced by the coffee tree. In the absence of a natural forest growth the leguminous trees guava (36) and guama (37), and to a less extent bucare (59), are planted instead. The shade trees and coffee bush are planted at the same time, the former by their naturally rapid growth reaching a size to afford the requisite protection by the time the coffee tree comes into bearing.

The coffee forests are of interest from the forestry standpoint chiefly because of the protection which they afford to the steep mountain slopes, although, on account of the relatively thin cover and the small amount of cultivation they get, a certain amount of soil erosion necessarily occurs.

CACAO PLANTATIONS.

Practically no cacao is now cultivated commercially, although formerly it was to a limited extent. It is a semiforest crop growing

[1] The coconut yields in addition "coir," a fiber obtained from the husks and used in the manufacture of cordage and for many other purposes; "copra," the dried meat of the nut, which when pressed yields coconut oil and a "cake"; besides the various uses of the wood. (See Appendix 1, under "Coco.")

[2] The advantages which may be attributable to the shading of the coffee, particularly when leguminous trees are used for this purpose, are as follows: The trees hold the soil in place, at the same time protecting the superficial roots of the coffee tree, require little care or replanting, discourage by their shade the growth of weeds, diminish the cost of cultivation, and lessen the bad effects of drought, act beneficially in breaking the force of the strong trade winds and of the pelting of the torrential rain, and enrich the soil. The actual shade itself, however, is said to be unnecessary and even prejudicial. The use of leguminous shade trees is said to be a remnant of a prehistoric agricultural practice employed in the cultivation of both cacao (chocolate) and coca (cocaine) by the natives of Central and South America before the advent of Europeans and is still in favor among them.

under a forest-tree shade, like coffee, but, unlike coffee, it does best in the low country at elevations below 500 feet. It is chiefly of interest here as offering a suitable means of restoring a forest cover and providing an agricultural crop on some of the less fertile cane lands,[1] where a forest cover is particularly desirable because of its influence on bird life so necessary to the control of insect pests.

FOREST INFLUENCES.[2]

Forests make their presence felt through their influence on climate, on stream flow, and on soil erosion. In a country as abundantly watered as is Porto Rico whether the forests cause slightly more rain in the aggregate matters little. Within the forests, particularly those in the mountainous interior, the temperature of the air is appreciably milder and the humidity relatively higher than in the open. One effect of this may be observed in the formation during the dry season of clouds above the forests of El Yunque and vicinity, when none exist elsewhere. These rapidly disappear as they pass on to the westward and come in contact with the columns of heated air rising from the open slopes and cultivated valleys toward Juncos and Caguas. The modifying influence is likewise manifested in the cool air which descends after sundown into the open cultivated valleys from the wooded slopes of the coffee district.

The most important influence of the forests is in the checking of floods and erosion, though the conditions in Porto Rico are such as to make control of floods by forestation alone impossible. Throughout a greater part of the year the forest soils, except those of the limestone hills, are nearly, if not quite, saturated with moisture. Steep slopes and rain in the form of brief but torrential downpours are the rule and complete a combination favorable to most rapid run-off. These make it necessary to supplement forestation by a

[1] Cacao undoubtedly could be grown as profitably in Porto Rico as in Granada (British West Indies), where conditions of configuration, rainfall, soil, trade winds, etc., are very similar and where an even greater density of population prevails. According to a "Report on the Economic Resources of the West Indies" (by Daniel Morris, assistant director Royal Gardens Kew, in Kew Bulletin of Miscellaneous Information, Additional Series 1, 1898) cacao was first planted in Granada on mountain lands as it formerly was in Porto Rico, the lowlands being entirely in sugar estates. But later it was tried on the lowlands and found to rival sugar in productiveness. In 1895 Granada was said to be the only West Indian colony of Great Britain that was independent of sugar. An especial feature of the cultivation of cacao is that it can be raised to advantage on small holdings.

[2] Of more than passing interest in this connection are the following observations by Col. Flinter (see Bibliography), written in 1834: "The government has most wisely ordered that three trees should be planted for every one cut down. It is to be hoped that this order may be rigorously enforced; for, in the first place, wood is the great and principal agent in the atmosphere for the attraction of the clouds, * * * If these laws on this head are carried into force by the local magistrates the island will always have on it an inexhaustible source of timber; but if, on the contrary, these useful precepts are not followed, water will become scarce; the rivers will dry up; the fields will become scorched savannas for want of moisture; the cattle will find neither food nor shade from the noonday sun; and this beautiful and fertile island will at once be deprived of its enchanting verdure, its fertility, and its riches. This is not the dream of imagination or the ridiculous prognostication of ideal ills. I am aware that this can not happen before the expiration of a century; but it *is the duty of governments and individuals to look forward to posterity. It is their duty, by wise and prudent measures, to foresee and prevent at the present day the ills which may be inflicted on future generations by undue considerations or concessions of temporary interests.*" (Italicizing is the author's.)

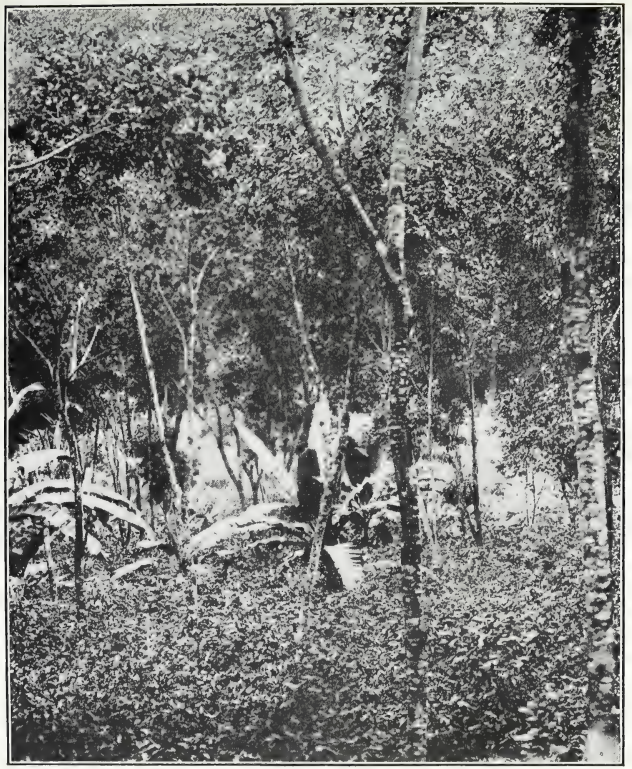


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FIG. 1.—A COFFEE FOREST.

Probably the most conspicuous forest growth on the island. Photograph shows the two-storied arrangement of the forest, camera being on a level with the top of the coffee bush.

F—52741

FIG. 2.—A COCONUT GROVE.

The most conspicuous tree growth along the coast.

CULTURAL FORESTS.

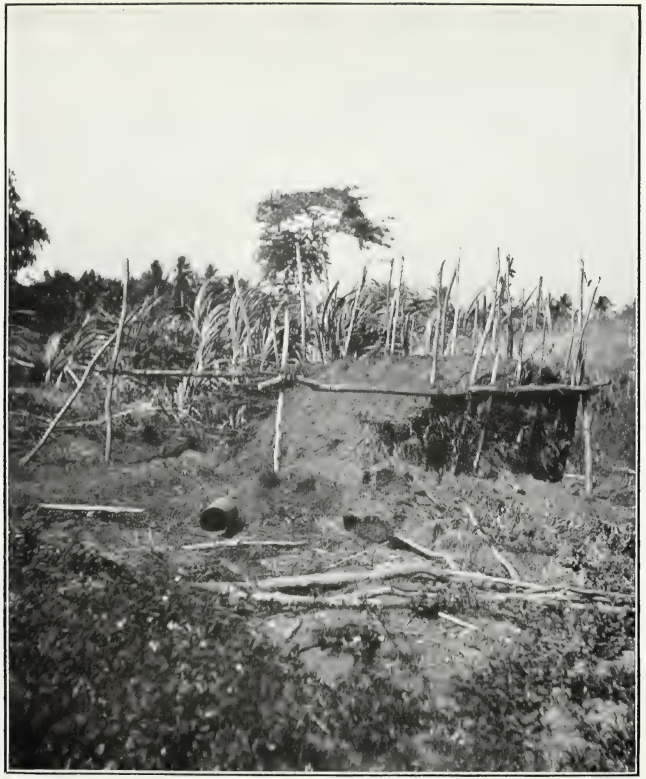

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FIG. 1.—CHARCOAL KILN IN OPERATION.

When these operations are extended to the steep mountain slopes the way is opened for a rapid run-off of the rain falling on such slopes and floods in the lower stream courses.

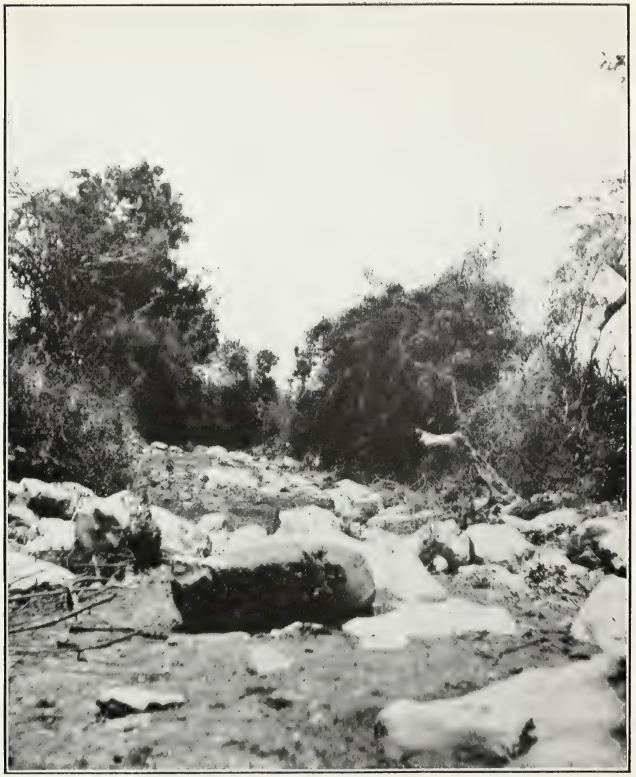

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FIG. 2.—STREAM COURSE FLOODED IN TIMES OF RAIN; DRY AND BOWLDER STREWN AT OTHER TIMES.

The banks are eroded away and fertile fields encroached upon are the indirect results of charcoaling and conuco farming on the steep mountain slopes.

succession of reservoirs and a cleaning up of the channels if any noticeable reduction of the eroding effects of floods is to be had.

Forests aid in conserving the water in the soil. The trees both aid the water in getting into the soil and then help the soil to hold on to it. In the first place, the trees break the beating force of the rain, which in the Tropics is considerable, and thus help to keep the surface layers of the forest soil from being beaten down and rendered compact and impervious like the soil in the open. Then the roots of the trees make the soil more open and accessible to percolating water. The roots and such ground cover and litter as there are impede the progress of surface run-off and afford the soil more time to absorb the water. With more water getting into the forest soil than in grassland soil, both being of a retentive character, there will be more water to find its way to springs and be gradually poured out into the rivers to sustain them during the periods of little rain.

The forest influences erosion in two ways: By reducing the force and interrupting the passage of the surface run-off in the catchment areas around the headwaters of the streams it slows up the washing away of the surface layers of the soil and greatly impedes gullying. At the same time the ability of the run-off to transport eroded material is very considerably lessened. A grass cover, if it forms a firm, well-knit sod, is also quite effective in resisting the erosive action of surface run-off. When, however, the grass grows in bunches and is interspersed with patches of bare ground or with tender, succulent herbage that dies out in dry weather, leaving the soil exposed, erosion and run-off is little affected. This is often the condition on the upper and drier slopes on the south side of the island. That these open slopes are not scored more deeply than they are is undoubtedly due in large measure to the tenacity of the soil.

It is when the run-off is gathered into the streams of the island and reaches the foothills country, where the character of the soil changes from the heavy clays of the interior to the lighter and more readily eroded coast soils, that the greatest damage is done. The rivers are generally too short to choke up and overflow, as would otherwise more frequently happen. Yet they are continually widening and shifting their channels, cutting off islands from adjoining fields, and undermining their banks. Frequently it is not so much the water that creates the havoc as the material which it picks up and transports. Besides the finer soil particles and gravel, large bowlders are dislodged and rolled along with great destructive force. Thus the volume of water which comes from the hills may in the course of its passage to the sea be doubled by the material transported by it or dumped into it from caving banks.

A fringe of forest growth along the banks will materially lessen the liability to this kind of erosion. Certain of the bamboos are par-

ticularly suitable for this purpose and formerly were plentiful along the water courses in Porto Rico. But since sugar cane has become the all-important crop in the lowlands, the bamboo has been sacrificed to secure a few more feet of land or because it shaded the cane planted near the edge of the field. The folly of this procedure can be seen in places where the extra feet of cane rows thus secured at the sacrifice of bamboo and several more with them have been subsequently undermined by flood and dumped into the river.[1]

The close relation of forests to stream flow and erosion is not difficult to observe in Porto Rico. Compare, for instance, the lower reaches of the north coast rivers, particularly those rising in the coffee district or the Luquillo, with the south coast rivers, as, for instance, the Portugues. The former have relatively few abandoned channel beds and less spreading stream bottoms, are obstructed only by sandy or gravelly bars and relatively small bowlders, and show a reasonable flow of water even in the dry months. The Portugues and other south-side rivers, which are largely fed by the rains falling on the steep grass slopes of the Cordillera Central, have wide, dry bottoms showing often no less than six different channels separated by low islands, and many shoals, remnants of a former river bank. The bowlders, which are everywhere strewn about, are several times the size of those in the north coast rivers, the banks are often steep and undermined, and the stream is of almost inconceivable insignificance on the midst of surroundings indicative of such destructive power. The many streams and waterfalls in the heart of the interior flow from the wooded slopes (even when swollen by heavy rains) practically clear, carrying but little sediment; on the other hand, the waters of the south coast embayments at the mouths of the rivers are red-brown in the flood season with the soil brought down by the rushing torrents.

Many examples might be found in the Tropics of serious injury resulting from destruction of the forest or of benefits following its restoration. Owing to reforestations effected on a large scale, the rainfall on the island of St. Helena has actually been doubled since the time of Napoleon I; and in Lower Egypt, where in the eighteenth century rain only fell on from 10 to 12 days in the year, the number of rainy days nowadays reaches from 30 to 40. On the other hand, in Syria and Palestine there are numerous regions which were formerly in a flourishing condition but have become arid and waste in consequence of the destruction of forests.[2] In the West Indies themselves, the experiences of Martinique are particularly instructive. Here as early as 1843 the man-

[1] The following, which bears closely on this situation, is quoted from the 1907 report of Lorrin A. Thurston, chairman of the committee on forestry of the Hawaiian Sugar Planters' Association:

"In the past the subject of forestry has been largely treated by this association as an interesting incident, but not as one of direct concern or of possible immediate benefit or profit to its members. *Within two years I have heard of trees bounding fields being cut out because the shade injured the adjoining cane.*

"In all earnestness I urge upon the association that the time for this view of forestry and its possibilities in Hawaii has passed, and that the preservation, propagation, and utilizing of forests and forest products should from this time forth be made one of the leading features of the efforts of the planters' association, both by it as an organization and through the individuals and corporations which give it its strength." (Italicizing is the author's.)

[2] General report by C. Capolletti, of the proceedings of the Navigation Congress at Milan in 1905.

ufacture of charcoal was recognized as the most serious single cause of the forest destruction which resulted in timber shortage, interruption and impairment of stream flow, soil wastage, damage to valuable agricultural lands through erosion, and shortage in the supply of water for power and other purposes. To remedy this situation the exportation of charcoal was prohibited, and stringent measures were adopted to regulate its manufacture, sale, and distribution. Most important of all, however, a forestry association [1] was formed which is supported by the Government. It has not only made a beginning in experimental reforestation, but is working through the schools, the celebration of Arbor Day, and the distribution of forest-planting stock at cost to arouse public interest in forestry.

The subject of conserving the forests for their influence on the water supply has not been without consideration in Porto Rico, since there appears in the "law of waters" this very significant language: "The colonial secretary shall also direct that a study be made of the portions of the basins and watersheds which it is advisable to keep wooded in the interest of a control of the water supply." [2] Like many another good piece of Spanish legislation, it remained legislation to the end. It is still, however, a part of the laws of the realm to-day and awaits as formerly official action. So much and more should be undertaken without delay.

COMMERCIAL ASPECTS.

In the larger commercial sense the forests of Porto Rico are insignificant. Leaving out of consideration coconuts and coffee, there is not a single article of export which is in any sense a forest product. The forests are, however, of tremendous importance as a source of domestic wood supply.

Local Timber and Wood Supply.

The estimated present resources of those forest lands capable of yielding saw logs are placed at 96,442,500 cubic feet (1,155,000 cords). Of this amount, however, there are only 4,592,500 cubic feet (27,500,000 feet, or 55,000 cords) of saw-log size, the great bulk being chiefly suitable for fuel, small house logs, and piling, posts, and the like. There are about 110,000 acres of such lands on which it is believed the average yield will not exceed 876.7 cubic feet (10.5 cords) per acre, of which 41.7 cubic feet (0.5 cord) will be found suitable for saw logs. On another 333,000 acres, comprising small wood and brush lands, including mangrove, the produce consists largely of fuel, house piling, and other small materials, averaging scarcely 334 cubic feet (4 cords) per acre. This will add another 111,222,000 cubic feet (1,332,000 cords) to the general resources. The total present supply is, therefore, 207,664,500 cubic feet (2,487,000 cords).

[1] "La Societe Martiniquaise des Amios des Arbres" was founded in November, 1909.

[2] Art. 59 of the Spanish law of June 13, 1879, which was extended over Porto Rico by Royal decree of Feb. 5, 1886, and reenacted and amended by the Legislative Assembly of Porto Rico, Mar. 12, 1903.

Stated in one lump sum it seems considerable, yet it is equivalent to scarcely 185 cubic feet per capita—less than the annual per capita consumption of the United States or Canada.

The value of this resource is $6,780,000, on the basis of 3 cents a cubic foot for all material except timber, which is estimated at 15 cents. The value of any by-products and the far more important soil protective value are, of course, left entirely out of account. The wood value alone, however, if invested at 5 per cent, would yield in interest approximately $340,000. The expenditure through an appropriation from the insular treasury of less than 6 per cent of this latter amount, or about $20,000, for a forest service to protect and improve the principal, would seem, therefore, to be a fully warranted, sound, and businesslike policy.

Lumber and Timber Imports.

Commercial expansion during the last few years has created a heavy demand for building lumber, timbers, and the like, which, because of the scarcity of suitable native woods, have been imported. Naturally most of this material has come from the United States, the Gulf ports more particularly.

Imports of forest products from the United States for the fiscal year 1911 totaled $1,308,579, an increase of 225 per cent over those of 1909. Besides this the United States supplied furniture and other manufactures of wood amounting to $684,560. Foreign lumber, timber, and manufactures to the amount of $131,623 were imported, of which material worth $14,616 came through the United States. The gross value from all sources was thus $2,124,762, of which lumber, timber, etc., exclusive of naval stores or manufactures of wood, amounted to $1,382,506.

The quantity of wood imported, exclusive of such products as shingles, box shooks, etc., amounts to 9,120,872 cubic feet (54,616,000 feet b. m.), including 8,382,064 cubic feet (50,192,000 feet b. m.) in lumber, scantling, and sawed timber from the United States, and 738,808 cubic feet (4,424,000 feet b. m.) from abroad. In addition, there was imported from the United States 26,717 cubic feet in hewed timber. Thus the grand total of wood imports amounted to 9,147,589 cubic feet, or about 8.2 cubic feet per capita.

Demands for Wood.

The demands for wood products are about half for commercial and half for domestic uses. Most of the commercial demands are supplied by imports. The commercial demands supplied by native-grown wood come chiefly from power development, which takes 3,633,336 cubic feet (43,513 cords) each year, equivalent to 3.25

cubic feet per capita.[1] The raw materials for the manufacture of furniture and novelties, native carts, ox yokes, and the like, also railroad ties, for narrow-gauge roads principally, posts and heavy structural timbers, in the aggregate probably amount to less than 1 cubic foot per capita.

Probably not less than 11,180,000 cubic feet (133,892 cords), equivalent to 10 cubic feet per capita, is consumed for domestic purposes. This means that an average family of five persons consumes only a little more than half a cord of wood each year. The demand for house piling, rafters, flooring, and the like is at the present time inconsiderable—not more than 2 cubic feet per capita (2,236,000 cubic feet)—because of the great scarcity of wood over most of the island and the prevailing low standard of living, especially among the rural population.

The various present demands for wood, aside from the manufactures of wood, may thus be summarized:

Character of demand.	Source of supply and uses.	Per capita.	Total.
		Cubic feet.	*Cubic feet.*
Commercial	Imports, building material, etc.	8.2	9,147,589
	Local, fuel only	3.25	3,633,336
Domestic	Local, fuel	10.00	11,180,000
	House pilings, and poles, posts, etc.	2.00	2,236,000
	Total	23.45	26,196,925
	Net total, excluding imports	15.25	17,049,336

NOTE.—The domestic demand is entirely an estimate; the commercial demand is based on the census and customs reports for 1910 and 1911, respectively.

The present status of the supply and demand is graphically represented in figure 7, which shows that the present per capita supply, at the rate it is now being consumed, will be exhausted in about 12 years. Yet at the present rate of production it will require more than 45 years to produce a similar supply, or nearly four times as

[1] Manufactures, Porto Rico; Bulletin of the Thirteenth Census, 1910: "Closely related to the question of kind of power employed is that of the fuel used in generating this power. * * * Porto Rico has no mineral fuel, and its wood supply is being depleted as manufactures increase. The following table shows the quantity of each kind of fuel used in 1909."

Industry.	Anthracite coal.	Bituminous coal.	Coke.	Wood.	Oil, including gasoline.	Others.
	Tons.	*Tons.*	*Tons.*	*Cords.*	*Barrels.*	*Tons.*
All industries	946	41,988	368	43,513	1,036	520
Bread and other bakery products	5	.....	6	13,444	75	.....
Coffee, cleaning and polishing	128	1,293	234	2,846	33	.....
Liquors, distilled	200	2,712	.....	737	.....	.....
Sugar and molasses	.....	31,808	.....	19,656	365	275
Tobacco manufactures	.....	790	.....	.....	17	.....
All other industries	613	5,385	128	6,830	546	245

long to produce as to consume it. New growth, however, during the period will extend the supply to slightly more than 16 years. It is, however, not to be expected that the island will be denuded of all woods at the end of this period. Experience teaches us that what actually happens in such cases is that consumption decreases as more

FIG. 7.—Per capita supply, production, and consumption of wood in Porto Rico, showing the rate at which present merchantable wood supply is being drawn on each year to meet domestic need, and the rate of its replenishment through new growth. The large circle represents the present per capita wood supply (185 cubic feet) exclusive of imports. The small circle represents per capita of wood production in one year (4 cubic feet), and the dot and dash circles the corresponding production per decade. (Based on a present annual growth of 10 cubic feet per acre per annum, equivalent to 4 cubic feet per capita.)

and more people are unable to pay the advancing prices. In the present instance it simply means a progressively increasing privation.

TREND OF FUTURE DEMANDS.

Education and the establishment of a more permanent form of agriculture will inevitably raise the standard of living among the lower classes and increase correspondingly the demands on the forests for both building materials and fuel, and besides these is the normally increasing demand occasioned by increased population. Kerosene and denatured alcohol can not, at least for a long time,

take the place of wood. The change would necessitate not only the displacing of the customs of centuries, but an investment in stoves and burners, which the average person can not afford. The domestic per capita consumption of fuel can therefore be expected to rise from year to year.

The sugar mills are now the largest commercial users of native wood. Under present improved methods the refuse cane fiber, known as "bagasse," is burned under the boilers, which effects a considerable wood saving. Some wood is still required to sustain this "bagasse" fuel, but as one "central" has already substituted crude oil for this purpose with satisfactory results, it is possible that in time all the larger mills at least may likewise adopt that fuel. It is thus probable that the maximum demands on the native wood supply have been reached by this industry. A gradual decline may consequently be expected.

The bakeries are the second largest commercial consumers of wood, and they demand cordwood of regulation size. The possibility of their changing to oil or other substitute fuel seems remote at the present time. The business is conducted on a small scale, with too limited a capital to justify such an outlay. The Army bakeries also consume a relatively large amount of cordwood. Any immediate decrease in demands of these or other industries where wood is largely used in the generation of power is thus hardly to be looked for.

BALANCING SUPPLY AND DEMAND.

Everything points to a sustained or an increased demand for wood. Commercial expansion can and will be taken care of by an increased volume of imports. But local and domestic needs accommodate themselves less readily and less promptly to new sources of supply. With production falling behind consumption, hardship and deprivation must be the inevitable consequences. This condition promises to grow more serious unless relief can be had through increased production. Two ways are open to effect this—planting new forests and improving the existing woodlands.

The restoration of a reasonable balance between cleared lands and forests is necessary. One-half million acres under prime forest growth will scarcely more than meet the situation. At present a large part of the 443,000 acres of timber and brush land yields not more than 10 cubic feet per acre a year, worth, at 3 cents per cubic foot, about $135,000. The improvement of these and the planting to new forest growth of 100,000 acres besides would provide approximately one-half acre of productive forest per capita, which is about the minimum required by a people to meet their own needs. A conservative estimate of the average annual growth to be expected on such area under forest management would be 30 cubic feet per acre,

worth in the aggregate approximately $490,000. Accordingly, to neglect to adopt a constructive forest policy for the future will mean the loss of a possible income from wood products of $355,000 per annum.

FOREST INDUSTRIES.

Charcoaling.

One could hardly expect that with depleted forests there would be many or very flourishing industries.[1] The charcoal industry is probably the leading forest industry of Porto Rico, as of many other of the West Indies. Charcoal is the fuel most generally used, particularly for domestic purposes. It is the only fuel of the poorer classes in the cities and is still in use to a great extent among the better classes also. Generally speaking, the charcoal is of exceedingly poor quality and small size. Some is scarcely larger than pea coal. Such stuff, the good and the bad indiscriminately, sells in San Juan for as high as 25 cents a can.[2] A sack holding about 2 bushels sells for from $1 to $1.25.[3]

The manufacturing part of the industry is carried on in a crude and haphazard way. All sizes of material, even to brushwood and small limbs scarcely one-half inch thick, and all kinds of wood are fired in the same heap. Because of its crookedness the wood is cut into short lengths—4 to 6 inches. The kilns are of poor and crude construction, and the fire control consequently is ineffective. Too rapid combustion is thus apt to occur and great waste results through the complete consumption of part of the wood, or incomplete combustion may leave some of the wood only partially carbonized, which renders the product very variable in burning and heating qualities.

The sources of supply are numerous. Most of the material comes from the clearing of land for agricultural use, but the mangrove swamps and the south coast hills furnish considerable. In some instances the charcoaling is done by contract with the bona-fide owners of the land, especially of land being cleared for the cultivation of sugar cane. In this case the large material is frequently cut and sold at from $1.50 to $2 a ton [4] to the "central." The charcoal opera-

[1] The census (1910) reports 8 establishments classed as "lumber and timber products" industries, having a total personnel of 171—26 proprietors, 22 clerks, and 123 laborers. These industries represent a combined capital of $113,392 and handle a product valued at $268,719, of which $90,301 is the value added by manufacture.

[2] Since the advent of the automobile the 5-gallon gasoline containers have become very plentiful and have been adapted to a variety of uses, one of which is as a unit of measure for the retailing of charcoal.

[3] A small amount of charcoal is brought in from Santo Domingo, but only one instance is known to the writer of any being brought from the mainland. The sale of this, however, under adverse market conditions yielded a slight profit and shows not only the high price of the native product but the possibility of developing a successful and profitable competition with it.

[4] The wood is thrown loosely into the car and is of varying lengths and frequently crooked. Under these conditions a car having a capacity of 1,000 cubic feet weighed 22,548 pounds, or about 22½ pounds per cubic foot. Making an allowance for the condition of the wood in the car, 150 cubic feet seems a fair equivalent of a properly cut and stacked cord. On this basis a cord would weigh about 3,400 pounds.

F–54250

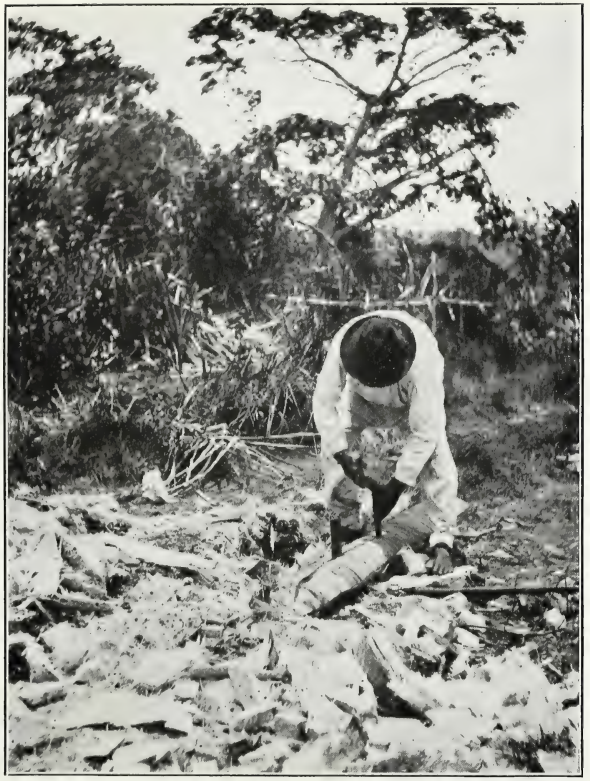
FIG. 1.—SAW-PIT IN THE HEART OF THE FOREST.

Trees often cut in such inaccessible places that the logs have to be squared and cut into plank where they are felled and carried out by hand or skidded a plank at a time.

F–37978

FIG. 2.—SKIDDING OUT PLANK SAWED IN THE FOREST.

Note the method of yoking the oxen. Skidding is done with these animals in what would seem impossibly steep places.



F–52713

FIG. 1.—CLAPBOARD MAKING: FROM THE HARD OUTER PORTION OF THE ROYAL PALM.

F–37945

FIG. 2.—NATIVE SAWMILL AND LUMBER YARD.

FOREST INDUSTRIES.

tor may be given the material for clearing up the land or he may pay the owner a stipulated amount per sack of charcoal yielded.

Often the charcoaling is not even done "by your leave," since it is an adjunct to "conuco" farming. When the squatter finds a piece of woodland which he wants to cultivate he may first cut such material as is suitable and make charcoal from it, or a charcoal burner may cut over a piece of land for charcoal without having an intention of subsequent cultivation. The public lands have by this process been largely despoiled of their forest growth.

Lumbering.

As an organized business lumbering hardly exists at all. Probably the nearest approach to it is in the Sierra de Luquillo, where a few lumbermen or woodcutters are to be found. They own their own implements and log on contract; that is to say, if any one wants a piece of ausubo for an ox yoke or bull cart or any other special material these men will go in and get it out for him. Their method of lumbering is a very gradual process of culling. Having found a suitable tree, they fell it and cut it into logs of the desired length. The log is squared with an adz, then a knob is fashioned at one end, to which a rope may later be made fast to drag it out by. Finally the log is placed on a rudely constructed scaffolding of poles erected on a hillside and sawed by the world-old pit-saw method. If they may be skidded directly from the pit, the planks are not sawed through the whole length of the log, but the log is left intact for a short distance back from the knob end to facilitate handling. Otherwise each plank is entirely severed from the log and carried out by hand to a place accessible to oxen. There the separate planks are assembled as they were in the log, a rope is made fast to the knob, and they are skidded the rest of the way to their destination or to where they can be loaded on a cart. The smaller logs and pole and post timbers are skidded singly or sometimes several at a time.

Skidding is accomplished by oxen on slopes where such work seems impossible. Grade appears to receive scant consideration, the skidding trails in places descending straight down the slope. Frequently these are hollowed out, whether intentionally or by the wearing of the logs is not evident, and stakes are driven at the side, where they turn sharply around a shoulder or follow obliquely down the hillside. After a time erosion supplements the wearing of the logs and the trails become so deep in places that they have to be abandoned.

Wood-working Industries.

With this system of lumbering there is, of course, no need for sawmills.[1] What few mills there are—located principally in the

[1] Flinter (see Bibliography) reported one water sawmill on the island in 1830 near Camuy.

seaport cities, San Juan, Mayaguez, and Ponce—resaw American lumber. Some of these carry a small stock of native logs which they saw on order for special work.

One of the largest manufactories on the island, located near San Juan, is devoted to the making of cigar boxes. The stock, cedro (71), for this factory is entirely imported, in large measure if not wholly, from Cuba. It comes in strips already cut to the proper thickness, namely, $\frac{1}{4}$ inch and $\frac{3}{16}$ inch. The annual consumption amounts to about 2,000,000 superficial feet, or something less than 1,000,000 feet b. m. A box of the size to hold 50 cigars contains about $1\frac{1}{2}$ square feet of material.

The trunk and match industries use considerable wood, but it is all imported. Furniture and other cabinet work and novelties, of which very little is produced, are to a large extent the product of hand labor. Native woods are almost exclusively used. The furniture is very excellently made, and, though of a style somewhat different and considerably more ornate than our furniture, is very attractive and pleasing. It especially brings out the beauties of the native woods, which, though practically unknown to commerce, possess very desirable qualities of both grain and color. The native furniture trade is unfortunately doomed to extinction, because of its inability to meet the competition of cheap machine-made furniture from the mainland.

FOREST PRODUCTS.

The forests of Porto Rico yield a large variety of gums, resins, fibers, coloring and dyeing materials, edible fruits, and the like, having a decided commercial value if systematically developed. Some of these are well-known articles of commerce, as anatto, fustic, and other coloring and dyeing materials. Although none are produced in sufficient quantity for export, most of them are to be found on sale in the public markets. It is doubtful if the various products and their still more varied uses have ever been completely catalogued. Many of the more important uses are given in Appendix 1, where, however, the wood uses are the ones chiefly considered.

FOREST PROBLEMS.

Every acre of land best suited, either temporarily or for all time, to forest production should be devoted to that use. Every acre of land around the headwaters and along the banks of the rivers on which a forest cover would offer a protection superior to the present cover against erosion and soil wastage should be forested. All forested lands and those to be forested should be so managed as to yield a maximum of the products most needed by the local communities and industries. The forestry program should also provide suitable

protection to the birds, live stock, and even man himself in the form, respectively, of small groves at intervals throughout the cane and tobacco districts, open cover in the pastures, and shade trees along the roadsides. Of scarcely less importance than these phases of the practice of forestry are painstaking investigations and a thorough campaign of educational propaganda.

Planting.

The planting of new forests is by far the most important, in point of magnitude at least, of the forestry work to be done in Porto Rico. Tree planting figured rather conspicuously in the early Spanish laws. "Law First"[1] of "Laws of the Indies," which concerned the allotment of lands to settlers, provided "two 'huebras' of land for orchard, and eight for planting other trees," while "Law Eleventh" promulgated by Emperor Charles in 1536, provided even more explicitly for the planting of "willows and trees," so that in addition to other purposes "it be possible to use the timber (wood) which might be necessary." As the Indies were generally well wooded, these laws, it may reasonably be inferred, were merely Spanish laws devised to meet conditions in Spain and more or less perfunctorily extended over the new possessions. Certain it is that they were never given force or effect in Porto Rico.

The need for reforesting the headwaters of the streams has already been mentioned. In most cases, however, protection can be as well supplied by the forests managed from the standpoint of wood production. It will not often be necessary to refrain from any cutting whatever. A system of harvesting the wood crop which will expose the soil on the steep slopes as little as possible to the unbroken force of the sun, wind, and rain, will usually be sufficient. For planting work along the streams to prevent the banks from washing, it may be necessary to adopt special material, such as bamboo. But with proper care even this could be harvested without impairing its usefulness as a soil binder.

In planting for the production of a wood crop the first consideration is, what products are most needed. Many would plant mahogany, ebony, rosewood, and all the other valuable cabinet and dye woods solely because they are valuable. Some time in the future it may be good forestry to try producing these woods for export, but that time will not come until the virgin supply of Santo Domingo and other countries is much nearer exhaustion and the growth qualities of these woods is much better known than now. In the meantime the home market is urgently in need of attention; its requirements are known, and it can be profitably supplied. Those trees which will produce fuel wood in the greatest abundance, the shortest time, and the most

[1] See p. 9.

suitable quality should unquestionably be the ones most extensively planted. What the species are that will best fulfill those requirements is now unknown and must be determined by experiment and investigation.[1] The discovery of the best varieties of woods for the manufacture of charcoal is also of the utmost importance.

Second only to the need for fuel is that for an increased supply of suitable woods for various native uses. At present the demand is more or less irregular and specialized. Particular kinds of wood have particular uses and there is practically no demand for wood for native house construction except for underpinning, sills, and the like. The advancement of civilization on the island will necessitate the improvement of housing conditions in the interest of public health, sanitation, and morality; and universal education through the public schools will inevitably set up a standard and a demand which will not tolerate present conditions. To meet this demand the properties of the various woods will have to be closely studied and very likely the introduction of some such species as the pine will be found desirable.

There is at least one native industry of large proportions that might possibly produce its own box material through the practice of forestry—the cigar industry. At present the cedro used by the Porto Rican trade comes almost exclusively from the virgin forests of Cuba. This wood is particularly prized for its lightness, clearness of grain, and strong yet pleasant aromatic odor. It is, of course, largely conjectural how far these properties would inhere in the wood of a planted growth. The cedro (71) is a rapid grower under favorable conditions of soil and climate.

Undoubtedly many trees could be planted which would yield products of bark, leaf, or sap for use as the basis of new industries.[2] The achiote might be set out on a steep hillside, several acres of it together. The gathering of the seed coats and the extraction of their coloring matter would furnish light labor for a number of persons at certain seasons of the year, if not the year round. Then there is the

[1] One such species undoubtedly is the *Acacia palida* (41), stands of which, according to investigations of the Philippine Bureau of Forestry, will yield over 13 cords per acre in 2 to 3 years. It is splendidly adapted for the reforestation of grasslands wastes either as a permanent crop or as a pioneer and nurse crop for subsequent plantations of more valuable but less hardy and aggressive species. It may also be planted to advantage on worn-out agricultural lands and, after one crop of firewood is harvested, the twigs and tops plowed into the soil as a green manure. (The author is indebted to Mr. H. M. Curran, formerly of the Philippine Bureau of Forestry, for calling his attention to the work done by that bureau and its published report concerning this tree, entitled "Ipil-Ipil—A Firewood and Reforestation Crop," by D. A. Matthews, Bulletin No. 13, Philippine Bureau of Forestry.)

[2] Dr. Seaman A. Knapp, in his "Report on Investigations of the Agricultural Resources and Capabilities of Porto Rico" (Senate Doc. 171, 56th Cong., 2d sess.), emphasizes the need of new industries. He says: "The early establishment of a number of minor industries closely related to agriculture is of vital importance to future prosperity. The object of such industries is to give profitable employment to the wives and children of farm laborers, so that the earning ability of the home may be doubled, and in some cases quadrupled. * * * Many philanthropic Porto Ricans suggested that the farm laborers on the coffee and tobacco plantations scattered upon the mountains * * * could never derive the full advantage of free education * * * until they were gathered into small villages and became amenable to society."

F–52710

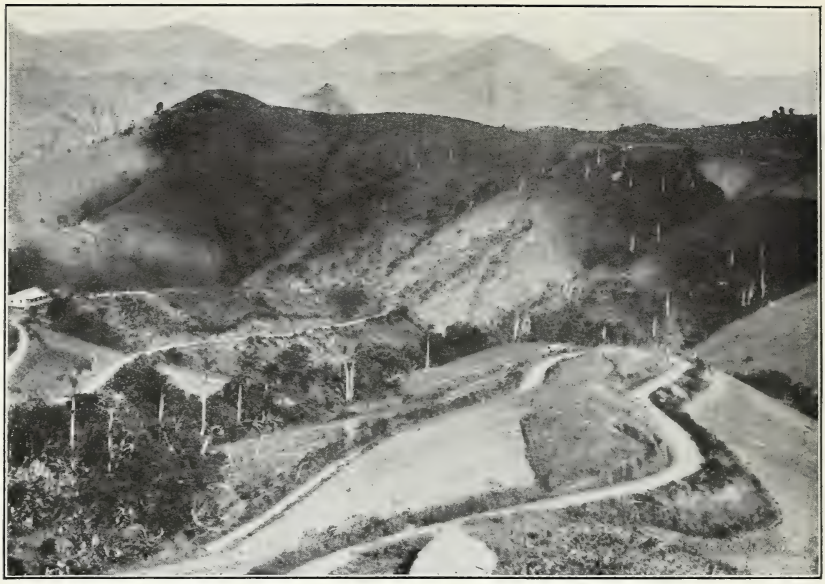
FIG. 1.—CORDWOOD ON THE CAR FOR SHIPMENT TO THE SUGAR CENTRAL.

These factories use nearly 20,000 cords per annum for power and heating purposes. (See note at bottom of page 41.)

F–52743

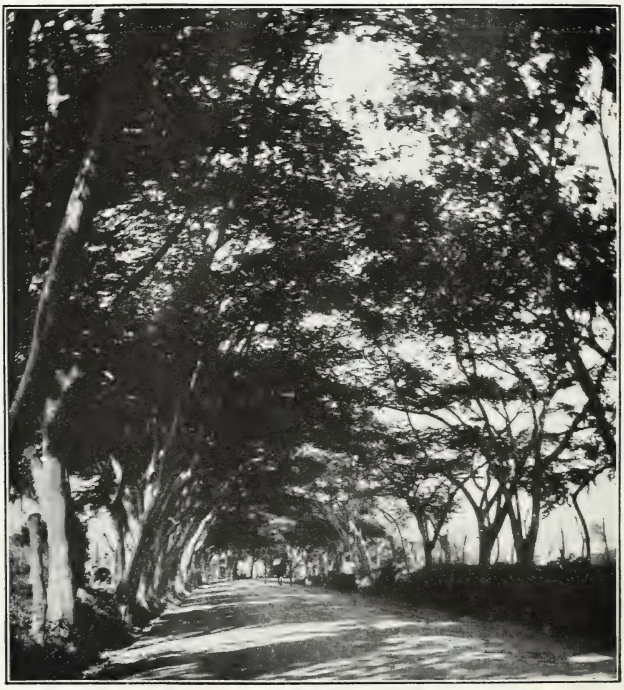
FIG. 2.—RAILROAD TIES.

Used largely on the narrow-gauge roads which bring the sugar cane from the field to the mill.



F–19764A

FIG. 1.—A SECTION OF THE COMERIO-BARRANQUITAS ROAD, ENTIRELY DEVOID OF SHADE OF ANY KIND.



F–27954A

FIG. 2.—THE FAMOUS MILITARY ROAD.

This stretch of roadway just outside of Caguas is attractively shaded by overarching flamboyan.

emajagua, which might be planted as a soil protector and yet be so managed as to yield a regular amount of fiber and fagots each year. The poma rosa could be made to furnish a continuous supply of hoop material for baling tobacco, fruit boxes, and the like, as well as fagots. The growing and tapping of tabanuco for its resinous sap likewise has possibilities. These and many others, the bamboos especially, are worthy of careful study and consideration

While recognizing the larger and more purely economic aspects of tree planting, it will not do to neglect esthetic and utilitarian considerations. No country can afford to be ugly or to neglect the comfort, both physical and mental, of its own or a visiting people. The roads of the island, particularly those through the lowland country, are usually hot and unattractive for lack of proper shade. There are some notable exceptions to this, but their occurrence serves rather to heighten the discomfort after they are passed. Such a one is the avenue of flamboyan bordering the military road between Caguas and Cayey. The kind of tree is of nearly as much importance as the fact that there are trees at all. Thus the almacigo and jobo, to mention two of the most common, have little to recommend them for roadside planting, except their ease of propagation and rapidity of growth. In the open country, trees that are tall and carry their branches high on a straight, clean trunk offer little obstruction to the view or to the circulation of air, yet they protect the roadway during the midday hours from the beating sun, and relieve the monotony of cultivated fields and pastures.

There is much concern about the scarcity of bird life in the cane country and the consequent prevalence of destructive insects. An occasional grove of trees would help this situation by furnishing the birds a refuge and nesting place; yet what few patches of woodland there are are constantly being cleaned up to get a few more square feet in cane.[1]

Systematic tree planting could be carried on in the pastures, even those which are actually utilized for grazing. There are several of the leguminous trees the pods of which are very nutritious and very

[1] In this connection the following from a letter of the U. S. Biological Survey to the Board of Commissioners of Agriculture published in its second annual report is of interest:

"In connection with the increase of island birds Mr. Wetmore suggests the great desirability of providing them with more shelter than they now have. The grackles and yellow-shouldered blackbirds, for instance, nest and roost in the palms. Can not the individual owners of plantations be sufficiently interested in the matter to plant royal palms along the roads leading through the cane fields? The island kingbirds appear to be very useful, and they need small perches from which to watch for insects. Bamboo planted along the streams and the drainage ditches would not only favor the three species mentioned above, but would also provide shelter from the sun for the green heron and the anis. For mocking birds, small brushy areas are essential, but these need not be of any great size, and if hilltops unfit for cane or other crops be left and not denuded of brush they will answer well the purpose.

"Mr. Wetmore further suggests that along the coast restrictions should be placed upon the total clearing of areas of mangroves by the charcoal burners, and special care should be taken not to disturb the rookeries of herons—the snowy, little blue, and little green species."

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much sought after by stock. These trees, besides affording food and shade for the cattle and naturally enriching the soil and improving the grass crop, could be cut at intervals for fuel.

Management.

The problems in forest management are those first of all which concern the protection of the present forests, such as the regulation of "conuco" farming, charcoal burning, and wood trespass in general, which alone will undoubtedly yield ample returns. Yet these little more than open the way to the real problems. The need for the improvement and conservative management of the mangrove has already been referred to. The insular lands, too, and to a large extent the privately owned lands which still remain forested, should not only be kept so but should be improved under systematic management. The nature of such management will depend on a variety of circumstances. Its fundamental purpose, however, will be to favor the growth and reproduction of those trees best suited to the needs which the particular forest is intended to serve. If the most suitable species do not occur in the original growth, it will be necessary to introduce one or more of them by planting; but careful investigation will usually discover among even those commonly thought to be useless qualities of excellence undreamed of.

Investigation.

In a country like Porto Rico, where so little is known about the native trees, their habits and requirements, it would be folly to ignore the needs for scientific study and research. The forest crop grows and matures comparatively slowly, and it accordingly takes several years for a mistake to become fully manifest. It thus will not do to go ahead blindly and plant large areas with little-known species, to find later that they are not suitable. Provision for investigative work is therefore indispensable to the practice of forestry.

Education.

One can not expect those who all their lives have been engaged in wasting and destroying what has come to them without exertion to see unaided the advantages of turning about and putting exertion into its production. Educational work of a very thorough and earnest sort is necessary to induce a people to support a tree-planting or other forestry campaign because usually the benefits are either obscure and indirect or are obtainable only by a future generation.

There are many educational means by which forestry can be carried to the people. The public-school system is, of course, one of the first and most effective means to be considered. Then the more advanced thinkers may be formed into forestry associations for discussion and propaganda, and others may be reached through popular publications, lectures, and the press.

Already a considerable interest is manifested by different branches of the insular government in improving forest conditions. Several of the sugar companies are also interested in planting up waste lands and in the open planting of leguminous trees in their bull pastures to provide green forage, improve the grass crop, and furnish shade for the stock. They are also planting for ornament about their grounds, along the roads, and bordering the cane fields.

INSULAR FOREST POLICY.

It must be evident that a program which has for its fundamental purpose the improvement of conditions affecting both directly and indirectly the interests of a whole people can not be left to private initiative. It must be undertaken and directed by the insular government itself. An efficient and well-equipped insular forest administration [1] should, therefore, be provided, and a forest policy be established which would make effective the following work: A campaign of education, investigative work in forestry, the care and management of the most suitable parts of the insular domain as insular forests, and cooperation with private individuals, municipalities, and others interested in the practice of forestry. The practice of forestry and forest experimentation is a distinctly long-time operation. In scarcely less than 10 years are any practical results forthcoming, unless an experiment results in conclusive and disastrous failure. Only when fuel wood or other small-sized material is the object of production can any conclusive results be obtained even in 10 years. For larger products 30 or more years will ordinarily be required. The necessity for taking a long look in advance and the desirability of fixing by permanent legislation the organization and scope of the work are thus apparent, stability, permanence, and continuity being indispensable conditions.

In weighing the advisability of taking such a step, the conditions and tendencies of the world supply of forest products can not be overlooked. The time is not far distant when the countries which produce the great bulk of the world's supply of the common economic woods will cease to have any considerable amount of timber to export. In anticipation of these conditions many of the producing countries have seriously set about making definite provisions for the future. If countries like the United States find it necessary to undertake the organized practice of forestry as a measure of self-protection, how much more necessary is it for Porto Rico to do so? The Philippines, too, maintain a technical forest organization, which

[1] Previous attempts to provide a forest administration were made in the Regulations for the Payment of Fees to the Technical Personnel of Public Works, Mines, Forests, and Telegraphs of the Island of Porto Rico, issued 1879, which provided, among other things, for the "inspection of forests for the formation of plans for their use." The Political Code for Porto Rico of 1902 (sec. 134) provides for "a chief of lands and forests which shall have charge of all matters relating to lands and forests." Neither of these laws, however, yielded any tangible results.

not only cares for their vast resources, but is undertaking the reforesting of the grassy wastes which have resulted from the same destructive agricultural practices that have devastated the Porto Rican forests, "conuco" cultivation. Hawaii for the last 10 years has maintained an active forest organization which has given special attention to watershed protection, and, although one-fourth of the total land area is still forested and largely permanently reserved and carefully protected, has done much forest planting besides. In fact, forest planting has been carried on by private enterprise in Hawaii for nearly a generation.

There is no country of all of these more favorably situated than Porto Rico to undertake the practice of forestry. Local market conditions can hardly be equaled anywhere. The forest soils are generally well isolated, and well and centrally located, and are thus admirably adapted to serve easily and at a minimum of expense the general needs of the surrounding population, at the same time affording protection to the headwaters of the more than a thousand streams of the island.

Needed Legislation.[1]

Laws concerning the forests and trees are no new thing to Porto Rico. Mention has previously been made of the early land laws, which required tree planting as a condition of the grant; of the "Law of Waters," providing for the study of the watersheds which it was advisable to keep wooded; of the "regulations" of 1879 concerning public works, which provided an apparently elaborate forest administration intrusted with "the inspection of forests for the formation of plans for their use"; and lastly to the provision in the Political Code of 1902 for a "chief of lands and forests." It is not known that these various works and officials ever existed except on paper, but certainly no tangible results from them have come down to the present day.

More recently, by the act of March 9, 1911, the legislative assembly created a Board of Commissioners of Agriculture[2] which has interested itself in forestry. The supervisory machinery is thus already in existence and its interest in the work already aroused.

[1] A forestry law was drafted along the lines discussed in these pages for inclusion herein as an appendix. It was, however, omitted as the bulletin was going to press and referred instead to the committee recently created by joint resolution [J. R. No. 3, approved April 3, 1916] of the legislative assembly "for the study of the forestry needs of Porto Rico." This committee is composed of the President of the Board of Commissioners of Agriculture, the Commissioner of the Interior, the Commissioner of Education, and the Special Agent in Charge of the Porto Rico Agricultural Experiment Station at Mayaguez.

[2] The president ex officio is a head of department designated by the governor. Of the other six members one must be a member of the House of Delegates and be designated by the speaker, while each of the commercial associations—Associacion de Puerto Rico, Associacion de Productores de Azucar, Associacion de Productores de Cafe, Associacion de Productores de Tabaco, and Associacion de Productores de Frutas—nominate one of the five remaining commissioners.

It is now only necessary to have the designation and powers of the board[1] extended to include the subject of forestry.

The law giving the board charge and direction of forestry work should also provide the technical machinery for carrying it into effect. A provision of first importance is one creating the position of insular forester and defining the qualifications for this office so as to insure the work being developed under a forester not only of liberal technical training but of practical experience as well. It is also essential to make the office strictly nonpolitical. This can best be done by setting a high standard of technical qualifications and making the incumbent subject to removal only upon his failure to measure up to the standard set or because of improper conduct. The position would thus come virtually under the classified civil service, as is the case in the Federal Forest Service. The insular forester would have immediate charge, direction, and control of all forestry matters, subject to the supervision and approval of the board.

Much requires to be done in a scientific way to learn the distribution, properties, and habits of the various trees suitable for forest planting and management. It would therefore be advisable to provide for the establishment of a forest experiment station. Here, in addition to other work, forest tree nurseries could be maintained and experimental tree planting done. In connection with such a station an arboretum might be developed where all the different trees of the island could be set out. Such an experimental garden would be of immense educational value. The data and experience of the station staff should be made available to the public through publications and lectures and cooperation with landowners in carrying on forestry work.

The insular government has at different places scattered over the island tracts of vacant land, much of which is now idle and unproductive, and generally located in out-of-the-way places. Some of it will always be most profitably utilized for growing timber. It would accordingly be extremely desirable to have all of these tracts carefully examined with the view to determining their adaptability to forest or agricultural use. As much as is unquestionably best suited to the growth of a forest cover or is not now available for other uses could very profitably be reserved for demonstration and experiment, permanently or otherwise as circumstances might warrant. Lands so reserved might very properly be constituted Insular Forests, and the power to set them aside by proclamation be reposed in the governor. After their creation they ought to be subject to the exclusive control of the insular forest service, which would have

[1] An amendment would also be desirable providing for a longer term for each of the five commissioners nominated by the different associations, the terms to be so arranged that not more than two would expire in any one year. This would insure a greater stability and continuity in the controlling policy and provide a long enough term to make it worth while for a member to familiarize himself with the work of the board.

the right to make and enforce all necessary rules and regulations for their protection and management, and to sell or lease under limited permit any products or uses.

In justice to a municipality in which an insular forest might be located, provision ought to be made that it receive a certain percentage of any revenue of such forest as recompense for loss in taxable income caused by the presence of tax-free government land. This method has been adopted by the Federal Government in reimbursing States on account of National Forests. A second method which aims to accomplish the same purpose and is now in effect in some of the States is for the State to pay to the county or town in which a State forest may be located a fixed sum annually, generally from 1 to 4 cents an acre, in place of taxes exempted from these lands.

During the first few years the work of the insular forest service would yield only such revenue as could be realized from the sale of seeds or seedlings which it seemed desirable to the board to dispose of. After the organization of the insular forests there would be some revenue from leases and other special uses, and later on a regular income from the mature timber. During the formative period, at least, it would be extremely desirable to cover into the insular treasury all revenues from forestry sources, to be constituted a special fund available for expenditure for any forestry purpose.

It is desirable to make the law as comprehensive as possible at the outset in order to outline in advance the full scope and significance of the work. The initial annual appropriations need, however, provide for only the few essentials required to get the work under way. An appropriation of $5,000 should be sufficient to cover the salary of the forester, his necessary field and office expenses, and the hire of any assistants he may need for nursery and investigative work. When it comes to establishing the experiment station, a special building and equipment fund of $10,000 will be necessary and an additional maintenance fund of $3,000 annually.

There are other considerations than those concerned strictly with forestry which merit legislative attention. The regulation of the indiscriminate and nomadic cropping of ground provisions and the equally indiscriminate practice of charcoal burning are of first importance. The most permanent and logical means are education and the definite establishment of land titles. A cadastral survey of the island has been repeatedly urged by the principal government officials, both present and past, who have come in contact with the land situation in any of its phases. The difficulties in levying taxes and in knowing what are and what are not government lands have already been mentioned. The further difficulty, and the one with which we are particularly concerned here, is the enforcing of the police powers against unlawful trespass on both public and private property. It is obvious that it must be known with certainty who

owns land before it becomes possible to enforce trespass laws with any degree of assurance. The establishment of the bounds of each man's lawful property by survey would remove this present difficulty and many others.

A temporary expedient to meet the "conuco" and the charcoal situation is to require a license. In the case of the "conuco" it would only be possible to carry out a definite plan of licenses or permits with respect to the public lands. In the case of charcoal burning the method of regulation employed in Martinique offers a favorable means of control. This law[1] provides in brief that before a man can manufacture any charcoal he shall declare his intention at the mayor's office and state also where he is to make it and in what quantity. The vendor of charcoal other than the manufacturer must also have a license. To secure such license the vendor must present a certificate from the mayor showing that the manufacturer has complied with the requirements of manufacture. Parties transporting charcoal for their own use or that of another must have a certificate from the police or mayor giving the residence of the person from whom it was bought, his license number, and the number and residence of the buyer. Retailers are prohibited from buying their supplies in other than the regular markets of the island, and appropriate penalties are provided for violating any of these provisions. Such a law as this properly enforced in Porto Rico would go a long way toward preventing indiscriminate charcoal burning.

THE LUQUILLO NATIONAL FOREST.

Upon the transfer of the island to American sovereignty the Spanish Crown lands in the Sierra de Luquillo [2] became the property of the Federal Government. Originally supposed to aggregate some 40,000 acres [3] and to embrace a considerable amount of practically virgin forest land which was rapidly being cut and destroyed, these lands were constituted the Luquillo Forest Reserve (now National Forest), by presidential proclamation January 17, 1903.[4] Recently completed surveys covering all but a small part of the central mountain area, however, indicate a reduction in acreage to not over 15,000 acres, including probably the entire "hurricane hardwood" type. Thus the timber producing possibilities of a considerable portion of the area are not very promising, judging from present knowledge of conditions. Nevertheless, for the present at least, these lands will be retained in public ownership and whatever forest growth there may be on them will be protected.

[1] A digest of this law has been referred to the committee mentioned in the note, p. 52.

[2] For forest description of this region see p. 31.

[3] Based on official records in the archives of the Division of Public Lands, Department of the Interior, Porto Rico.

[4] The recommendation that this be done was made by Dr. Walter H. Evans, Chief of Division of Insular Stations, States Relations Service, U. S. Department of Agriculture, while the exploratory survey upon which the boundary proclamation was based was made by Mr. O. W. Barrett, at that time Botanist of the Porto Rico Agricultural Experiment Station.

APPENDIX I.

TREES OF PORTO RICO.

By W. D. Brush, *Scientific Assistant*, and Louis S. Murphy, *Forest Examiner, Forest Service;* and C. D. Mell, *formerly Assistant Dendrologist, Forest Service.*

INTRODUCTORY NOTE.

Much has been published concerning the flora of Porto Rico, yet little of it is available for general use, particularly concerning the trees. Hill in his bulletin on the Forests of Porto Rico (Bul. 25, Forest Service) listed some 60 different kinds of trees, and the woods of 15 of these were described by Sudworth. The work of Gifford and Barrett (Bul. 54, Forest Service, "The Luquillo Forest Reserve, Porto Rico") has already been referred to.

As to arrangement and nomenclature particularly, the principal reliance in preparing this present compilation has been Ignatius Urban's Symbolæ Antillanæ Seu Fundamenta Floræ Indiæ Occidentalis. Scientific equivalents have been given only in cases where they appear to be in well-established popular usage, as, for example, *Roystonia borinquena* for *Oreodoxa caribaea*.

Acknowledgment is also due to the authors of the above-mentioned Forest Service bulletins, Cook and Collins (Economic Plants of Porto Rico), W. Harris (The Timbers of Jamaica), John T. Rae (West Indian Timbers), and numerous other authorities for descriptive data concerning the uses of the wood and other products of the trees listed. Special acknowledgment is due to Miss J. S. Peyton for painstaking work in the preparation of the index and comparing the spelling of both common and scientific names in the final copy of the manuscript with the original authorities.

The microscopic descriptions of wood structure of the species marked with an asterisk, thus (*8. *Chlorophora tinctoria*) are based on examination by Messrs. Mell and Brush of wood samples in the Forest Service wood collection.

It has been the intention of the authors to include all erect woody plants which attain a height of 15 feet or over, including the tree cactuses and opuntias. The heights and diameters, it should be remembered, represent the extreme sizes which the species have been reported to attain, and are thus often considerably larger than those commonly met with. For convenience in reading, the technical wood descriptions, the less important species, and all but the most common exotic species have been subordinated to the general text. Little-known species and species and genera of very minor importance have been combined where possible and subordinated into notes, yet for completeness have been included.

Following is a synopsis showing the families represented, 57 in all, and the number of genera and species in each family. The genera total 172 and the species 292:

Family.	Genera.	Species.	Family.	Genera.	Species.	Family.	Genera.	Species.
Palmæ	4	5	Malpighiaceæ	1	2	Thymelaeaceæ	1	2
Juglandaceæ	1	1	Euphorbiaceæ	9	11	Rhizophoraceæ	2	2
Ulmaceæ	1	1	Anacardiaceæ	4	5	Combretaceæ	5	5
Moraceæ	6	9	Aquifoliaceæ	1	2	Myrtaceæ	5	13
Polygonaceæ	1	8	Celastraceæ	1	1	Melastomataceæ	4	10
Nyctaginaceæ	1	1	Staphyleaceæ	1	1	Araliaceæ	2	3
Magnoliaceæ	1	2	Sapindaceæ	5	6	Myrsinaceæ	1	2
Anonaceæ	4	9	Sabiaceæ	1	2	Sapotaceæ	7	17
Lauraceæ	6	17	Rhamnaceæ	1	2	Ebenaceæ	2	2
Hernandaceæ	1	1	Elaeocarpaceæ	1	1	Symplocaceæ	1	5
Cappardiaceæ	1	2	Malvaceæ	2	3	Styracaceæ	1	1
Brunelliaceæ	1	1	Bombacaceæ	4	4	Oleaceæ	1	1
Rosaceæ	2	3	Sterculiaceæ	1	2	Apocynaceæ	2	2
Leguminoseæ	22	30	Ternstrœmiaceæ	3	5	Barraginaceæ	1	6
Zygophyllaceæ	1	2	Guttiferæ	4	5	Verbenaceæ	5	6
Rutaceæ	4	14	Bixaceæ	1	1	Bignoniaceæ	3	6
Simarubaceæ	2	2	Winteraceæ	2	2	Rubiaceæ	11	16
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DESCRIPTION OF SPECIES.

I. Palmæ.

1. *Inodes causiarum* Cook. Yaray; Porto Rican hat palm (Br. W. I.).
Inodes glauca Urb. Damm. Palma de sombrero; Hat palm (Br. W. I.).

Two palms more or less common on the western end of the island, usually along the shore on the coral sand. The leaves are held in high repute in Porto Rico for making hats, immense quantities of which are manufactured every year. The center of this industry is at Joyua, just south of Mayaguez.

2. *Oreodoxa caribaea* (Spreng.) Damm. & Urb. (=*Roystonea borinquena* Cook?=O. *regia* Bello?). Palma real, Yagua, Palma de yaguas, Palma costa, Palma de grana; Palmacte, Pumu (Sp. W. I.); Royal palm (Br. W. I.).

Tree from 40 to more than 80 feet high and sometimes 2 feet in diameter, found throughout the island, the West Indies, and southern Florida. One of the most conspicuous objects in the Porto Rican landscape. The most useful part is the sheathing base of the leaf called "yagua," which is used for roofing and siding of huts, and for a great variety of other purposes, especially by the poorer classes. The outer portion of the trunk is used for boards, posts, poles, piles, etc. The leaves are used for thatching roofs. The royal palm has more economic uses than any other tree in the West Indies.

3. *Acrista monticola* Cook. Palma de la Sierra, Palma de Sierra, Yagua del Monte.

Tree from 30 to 80 feet high and from 12 to 18 inches in diameter, closely allied to the royal palm (*Oreodoxa caribaea*). The Porto Rican species is confined chiefly to the mountain regions. The outer portion of the trunk, split into boards, is used for making huts, and the leaves for thatching roofs.

4. *Cocos nucifera L.* Palma de coco, Coco, Cocotero (Sp. W. I.); Coconut, Porcupine wood, Coco palm (Br. W. I.).

Tree usually from 40 to 50 feet tall and from 12 to 15 inches in diameter, found everywhere along the coast in Porto Rico, the West Indies, and the Tropics generally. Extensively planted and of great economic importance. The "milk" of green fruit is in great demand locally. It is drunk directly from the nut, which is then thrown away. The ripe fruit is exported in large quantities. The wood is used for walking sticks, umbrella handles, posts, piles, and for other purposes requiring strong and durable material. The fiber of the husk, known as coir, and the dried meat of the nut, known as copra, both important articles of export from the East Indies to Europe, have no commercial value in Porto Roco.

The wood is somewhat similar to that of the royal palm, very hard, heavy (about 50 pounds per cubic foot), strong, tough, and very durable in contact with the soil.

II. Juglandaceæ.

5. *Juglans jamaicensis* C. DC. Nogal, Palo de nuez; Jamaican or West Indian walnut (Br. W. I.).

Tree from 40 to 80 feet high and from 18 to 24 inches in diameter, occurring only at high altitudes on the island. The wood is similar to that of our native Butternut (*Juglans cinerea* L.) but is seldom used except occasionally for furniture.

III. Ulmaceæ.

6. *Trema micranthum* (L.) Bl. Palo de cabra, Guacimilla, Guazymillo; Ixpepe (Mexico).

Tree from 15 to 60 feet high, occurring here and there throughout the island. Wood little used. Wood light brown, moderately fine grained; capable of a good polish, but rather soft, light, and weak. Pores small, isolated, or in groups of two to five or more, and evenly distributed. Pith rays minute, inconspicuous.

IV. Moraceæ.

7. *Trophis racemosa* (L.) Urb. Ramon,[1] Ramoncillo.

Tree from 30 to 50 feet high, occurring in the northwestern part of the island, chiefly of importance on account of the leaves, which are used as fodder for cattle and horses. Its wood is good for all purposes except in exposed situations.

***8.** *Chlorophora tinctoria* (L.) Gaudich. Mora, Palo de mora, Fustic.

Tree from 45 to 65 feet high and from 18 to 24 inches in diameter, occurring mostly in the southwestern part of the island. The wood is used locally for shelving in country houses and for spokes of wheels; also for furniture and wherever great strength and durability are required. This tree, which occurs throughout the West Indies and Central America, furnishes one of the most important dyewoods of commerce.

Wood [2] a handsome brownish-yellow, very fine-grained. Pores small, isolated or in groups of two to four, more or less connected by short wavy tangential lines of wood parenchyma, which are conspicuous on a transverse surface. Pith rays very narrow and inconspicuous. Wood takes a fine polish, hard, heavy (about 44 pounds per cubic foot), strong, tough, and durable.

***9.** *Artocarpus incisa L.* (=*Artocarpus communis* Forst.). Pana, Palo de pan, Castaña; Bread fruit, Bread nut (Br. W. I.).

Tree from 40 to 60 feet high, introduced from the East Indies, now growing spontaneously in many parts of the island, particularly the north side. The fruit is very large with numerous large seeds resembling the Spanish chestnut, whence the common name "castaña." These seeds are an important article of native food. Wood, though little used, is said to be highly appreciated for furniture and for building houses.

Wood is yellowish-gray in color; rather light and soft, but strong, resistant, and elastic. Its specific gravity is given as 0.495 (C. & C.).

10. *Pseudolmedia spuria* (Sw.) Griseb. Negra lora.

Tree from 25 to 50 feet high with a limited distribution on the island. It is of very little use except for fuel and charcoal.

***11.** *Ficus lævigata* var. *lentiginosa* subvar. *subcordata* (Warb.) Urb. (=*F. lentiginosa* Vahl.). Jagüey, Jiguerillo, Lechesillo.

Tree from 30 to 60 feet high and from 4 to 5 feet in diameter, occurring quite generally in the mountainous regions. It is at first semiepiphytic and often destroys, trees on which it grows. It is used in making fishing canoes.

Wood light gray with narrow brown lines of softer tissue, fine, and straight-grained moderately soft and light (about 30 pounds per cubic foot). Pores small, solitary or in groups of two to four, evenly distributed. Tangential lines of wood-parenchyma fibers visible on a smooth transverse surface. Pith rays very narrow and indistinct.

Note.—Similar to the above in the uses and properties of their wood are *Ficus sintenisii* Warb. (Jagüey, Higuillo preto) and *Ficus stahlii* Warb. (Hagüey, Jagüey) trees, 15 to 60 feet high, which occur in the mountainous regions. Several other species of *Ficus* known locally as "Higuero" are reported as being generally distributed throughout the island. These are small trees averaging from 10 to 20 feet high and from 4 to 6 inches in diameter. The wood, which is very little used, is white, soft, light (about 43 pounds per cubic foot), and not strong nor durable in the soil.

Another species *Ficus nitida* Thumb. (Laurel de India, Laurel), introduced from Asia, is a beautiful tree from 45 to 65 feet high and has been planted on the island for ornamental purposes. The wood is not used.

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[1] This tree must not be confused with the bread-nut tree (*Brosimum alicastrum* Sw.), which is also called "Ramon" throughout the West Indies and Yucatan. The latter is a native of Jamaica but has not been reported from Porto Rico.

[2] See pp. 12-14, Forest Service Circular 184.

12. *Cecropia peltata* L. Yagrume hembra, Llagrumo, Trumpet tree; Guarumbo, saruma (Mexico).

Tree from 20 to 60 feet high and from 10 to 12 inches in diameter, occurring in mountainous regions. It is common throughout the West Indies. The trunks and branches are hollow and are often made into carrying poles and floats for fishing nets. Wood white, light, soft, moderately weak, and not durable in contact with the soil.

V. Polygonaceæ.

***13.** *Coccoloba rugosa* Desf. Ortegon.

Tree from 40 to 100 feet high, occurring from sea level to 2,000 feet elevation, abundant along the coast. Wood useful for construction timber. Wood purplish, fine-grained, hard, heavy, strong, and tough. Pores very small, isolated or in groups of two or three, evenly distributed. Pith rays narrow, inconspicuous.

***14.** *Coccoloba uvifera* (L.) Jacq. Uvero, Uva del mar, Sea grape.

Tree from 15 to 30 feet high and from 3 to 4 feet in diameter, growing along the coast. The trees are reproduced by cuttings. The wood is highly esteemed for cabinet work. Wood dark brown with nearly black linear markings, very fine-grained, taking an excellent polish, very hard, heavy (65 pounds per cubic foot), strong, and tough. Pores very few, very small, isolated or in radial rows of two to four. Pith rays narrow, inconspicuous.

***15.** *Coccoloba grandifolia* Jacq. Moralon.

Tree from 50 to 60 feet high and from 1 foot to 2 feet in diameter, occurring in mountain forests. Reported formerly very common in the vicinity of Lares and throughout the limestone belt from Ciales and Utuado to the west coast. It is also native to others of the West Indies and to Mexico and Guiana. Wood was highly prized for building purposes and for furniture and cabinet work, but is now scarce.

Wood reddish, close and sometimes cross-grained, very hard, and heavy. Pores minute, isolated, or in groups of two or three, evenly distributed. Pith rays minute, very inconspicuous.

Note.—Other species of this genus are **Coccoloba nivea* Jacq. (Calambreñas); *Coccoloba laurifolia* Jacq. (Uvillo, Cucubano, Gateado, Glateado, Uverillo); *Coccoloba obtusifolia* Jacq. (Uvillo); *Coccoloba diversifolia* Jacq. (Palo bobo); *Coccoloba urbaniana Lindau.* (Ortegon). Trees from 15 to 45 feet high, growing mostly in the mountains, and yielding fine and useful timbers. Wood in general similar to the above.

VI. Nyctaginaceæ.

16. *Pisonia subcordata* var. *typica* Heimerl. Corcho, Palo bobo.

Tree from 40 to 60 feet high, occurring here and there throughout the island. Wood of very little use.

VII. Magnoliaceæ.

***17.** *Magnolia splendens* Urban. Laurel sabino, Laurel savino, Laurel, Sabino.

Tree from 50 to 100 feet high and from 1½ to 2½ feet in diameter, found in all parts of the island, though now very scarce. One of the most valuable timbers on the island, and used for beams, boards, and furniture.

Wood clear olive-brown, often turning yellowish-green, beautiful, aromatic, straight and fine-grained, resembling the wood of tulip poplar (*Liriodendron tulipifera* L.) and cucumber tree (*Magnolia acuminata* L.) with which it is closely allied. It is moderately hard, heavy, strong, tough, and very durable in contact with soil and air. Does not warp or check during seasoning. Pores very small, solitary or in pairs, and evenly distributed throughout the annual rings of growth, which are marked by more or less distinct narrow lines of radially compressed wood fibers. Pith rays very narrow, scarcely visible on a polished radial surface.

Note.—*Magnolia portoricensis* Bello (Burro, Mauricio) recognized by Bello as a separate species is a tree from 45 to 80 feet high. It is reported only from the western part of the island. Wood similar to that of *M. splendens*.

VIII. Anonaceæ.

18. *Oxandra lanceolata* (Sw.) Baill. Haya prieta; Black lancewood, True lancewood (Br. W. I.).

Tree from 20 to 30 feet high and from 8 to 12 inches in diameter with a limited occurrence in the western part of the island. It occurs largely throughout the West Indies, and in parts of South America where the wood is highly esteemed for lances, fishing rods, shafts, spars, ramrods, and general turnery.

Wood yellow, very fine-grained, hard, light, strong, and very elastic. Pores are minute, solitary or in groups of two to five, radially disposed, and evenly distributed. Pith rays narrow, scarcely visible to the unaided eye.

19. *Oxandra laurifolia* (Sw.) A. Rich. Yaya, Yaya blanca, Haya blanca, Purio; White lancewood (Br. W. I.).

Tree from 30 to 80 feet high and from 10 to 20 inches in diameter. It occurs in the mountain forests and is distributed throughout the West Indies. It is used largely for the same purposes as the true lancewood (*Oxandra lanceolota*), but is not so valuable.

Wood light yellowish and fine-grained, hard, light, and strong. Pores minute, solitary or in small groups, and evenly distributed. Pith rays inconspicuous.

20. *Guatteria blainii* (Griseb.) Urb. Haya, Haya minga, Negra lora.

Tree from 30 to 60 feet high, quite generally distributed throughout the island.

***21.** *Anona muricata* L. Guanábana; Soursop (Br. W. I.).

Tree from 10 to 35 feet high and from 6 to 12 inches in diameter, extensively cultivated throughout the island for the sake of its fruit, which has an agreeable slightly acid flavor, and is closely allied to the East Indian species (*Anona squamosa* L.). Wood of little use except for fuel.

Wood light brown, turning darker with age, fine and straight-grained, resembling somewhat the wood of our papaw (*Asimina triloba* Dunal.), which is called "*Anona*" in Spanish. It is soft, light, not strong, brittle, not durable in contact with the soil. Pores very small, solitary, or occasionally in pairs, and very evenly distributed throughout the annual rings of growth, which are scarcely visible to the unaided eye. Pith rays numerous and indistinct.

22. *Anona palustris* L. Cayul, Cayur, Anon, Corazon cimarron, Cayures, Corcho; Alligator apple, Cork wood (Br. W. I.).

Tree from 20 to 30 feet high and from 8 to 12 inches in diameter. It grows usually in swampy localities and is found along the coasts. Wood used for rafts, floats for fishing nets, and as stoppers for bottles. Wood gray or light brown, somewhat tinged with green, lustrous, fine and straight-grained, soft, very light, weak, not durable in contact with the soil, resembling that of the papaw (*Asimina triloba* Dunal.). Pores small, solitary or in small groups, and evenly distributed. Pith rays scarcely visible to the unaided eye.

23. *Anona squamosa* L. Anón, Anonde escamas, Chirimoya, Cherimolia; Sweetsop; Sugar apple (Br. W. I.).

Tree from 10 to 20 feet high. An East Indian species, introduced into all tropical countries, and now extensively cultivated for its fruit. It is found in most parts of the island. The wood is of little use. Wood light brown streaked with yellow, fine-grained, moderately soft, light, weak, brittle, and not durable in contact with the soil.

Note.—Of the other two species found on the island, *Anona reticulata* L. (Corazon; Custard apple, Bullock's heart [Br. W. I.]) is a tree from 15 to 30 feet high and from 6 to 12 inches in diameter, extensively cultivated throughout the island for the sake of its fruit, *Anona montana* Macf. (Guanávana cimarrona), which attains a height of from 30 to 50 feet, occurs chiefly in mountainous regions. The wood of both is similar to that of the other species and is of little use except for firewood.

24. *Rollinia mucosa* (Jacq.) Baill. Anon; Lancewood (Br. W. I.).

Tree from 30 to 50 feet high and from 8 to 12 inches in diameter, of limited occurrence in Porto Rico. Indigenous also to several islands in the Lesser Antilles, to Trinidad, and to Mexico. The wood is said to be occasionally used as a substitute for the true lancewood (*Oxandra lanceolata*), which it resembles. Wood light yellow, moderately hard, heavy, strong, and tough.

IX. Lauraceæ.

25. *Persea americana* Mill (=*P. gratissima* Gaertn.). Aguacate, Avocate, Avocado; Alligator pear, Butter pear (Br. W. I.).

Tree from 30 to 40 feet high and from 12 to 18 inches in diameter introduced from Mexico and now growing spontaneously throughout the island. It is widely planted throughout tropical and subtropical regions for its edible pear-shaped fruit. The fruit yields an abundance of oil for burning and for soap making. A deep indelible black juice used for marking linen is obtained from the seeds. The wood is suggested for use in cabinetmaking.

Wood light reddish-brown, beautifully figured and fine grained, soft, light (about 40 pounds per cubic foot), and brittle. Pores small, numerous, isolated or in groups of two or three, evenly distributed throughout the annual rings of growth, which are only faintly visible. Pith rays very minute and inconspicuous.

Note.—*Persea krugii* Mez. (Canela) is reported as a tree from 30 to 50 feet high, with a very limited occurrence on the island. Wood similar to that of the above.

***26.** *Phoebe elongata* (Vahl.) Nees. Avispillo, Laurel, Laurel bobo, Laurel geo-geo.

Tree from 30 to 60 feet high and from 1 foot to 2 feet in diameter, from the Luquillo region. Wood light brown, fine, and cross-grained, taking a good polish; hard, heavy, strong, and tough. Pores very small, evenly distributed. Pith rays very narrow and inconspicuous.

Note.—*Phoebe montana* (Sw.) Griseb. (Laurel, Avispillo), another species of this genus is of limited occurrence in the interior of the island and is similar in size and in the character of its wood.

27. *Ocotea.*

A genus of limited occurrence and little known uses in Porto Rico, is represented by the six following species: *Ocotea wrightii* (Meissn.) Mez. (Canela, Canelon); *Ocotea moschata* (Meissn.) Mez. (Nemoca, Nuez moscada, Nuez moscada cimarrona, Nuez moscada del pays, nutmeg); *Ocotea cuneata* (Griseb.) Urb. (Sassafras, Laurel sassafras); *Ocotea floribunda* (Sw.) Mez. (Laurel); *Ocotea leucoxylon* (Sw.) Mez. (Cacaillo, Laurel, Laurel bobo, Laurel geo, Laurel geo-geo); *Ocotea portoricensis* Mez. (Laurel, Laurel avispillo, Laurel geo). Trees from 30 to 90 feet high and from 1 foot to 3 feet in diameter, occurring in mountain forests. The wood resembles that of *Phœbe elongata.*

28. *Nectandra.*

The following five species of this genus are reported from Porto Rico: *Nectandra sintenisii* Mez. (Laurel, Laurel amarillo, Laurel blanco, Laurel geo, Laurel macho); *Nectandra krugii* Mez. (Laurel, Laurel canelon); *Nectandra membranacea* (Sw.) Griseb. (Laurel, Laurel geo-geo, Laurelillo); *Nectandra patens* (Sw.) Griseb. (Laurel, Laurel roseta); *Nectandra coriacea* (Sw.) Griseb. (Avispillo, Laurel). Trees from 30 to 70 feet high, occurring mostly in the mountains of the Luquillo region, and relatively unimportant. Wood light brown. Pores small, isolated or in groups of two or three, evenly distributed. Pith rays minute, inconspicuous.

29. *Hufelandia pendula* (Sw.) Nees. Aguacate cimarron, Cedro macho, Laurel, Palo colorado.

Tree from 50 to 60 feet high and from 1 foot to 1½ feet in diameter, occurring in mountainous regions. Wood yellowing-brown turning darker with exposure to air and light. It is fine and straight-grained, hard, moderately heavy, strong, and tough. Pores numerous, small, and evenly distributed. Pith rays narrow and inconspicuous.

30. *Acrodiclidium salicifolium* (Sw.) Griseb. Canela, Canelillo.

Tree from 25 to 50 feet high. Common in the mountainous districts, but of slight economic value.

X. HERNANDIACEÆ.

31. *Hernandia sonora* L. Mago.

Tree from 30 to 60 feet high, with a limited occurrence in the mountains of the Luquillo region. Wood little used. Wood cream colored, fine-grained, rather soft and light. Pores visible to the unaided eye, isolated or in groups of two to six, often more, evenly distributed.

XI. CAPPARDIACEÆ.

32. *Capparis portoricensis* Urb. Burro, Burro blanco.

Tree from 45 to 60 feet high, found near the southern coast. Wood white or light yellow, fine-grained, taking a good polish, moderately hard and heavy. Pores small, isolated or in groups of two to four, evenly distributed. Pith rays narrow, inconspicuous.

NOTE.—*Capparis jamaicensis* Jacq. (Burro, Palo de burro Prieta), is reported as a shrub or tree from 10 to 50 feet high, occurring along the coast. Wood similar to the preceding.

XII. BRUNELLIACEÆ.

33. *Brunellia comocladifolia* H. & B. Palo bobo.

Tree from 45 to 60 feet high, of limited occurrence in the mountainous region of the island.

XIII. ROSACEÆ.

34. *Prunus occidentalis* Sw. Almendron, Almendrillo.

Tree from 40 to 50 feet high and from 1 foot to 2 feet in diameter, common throughout the island. Wood employed, like the black cherry (*Prunus serotina*), for cabinet work and interior finish of houses.

Wood light brown, fine and straight-grained, taking an excellent polish, and often difficult to distinguish from light-colored mahogany. It is hard, heavy (about 66 pounds per cubic foot), strong, moderately tough, and very durable under water. Pores small, numerous, evenly distributed throughout the annual rings of growth, which are easily seen on a smooth transverse section. Pith rays moderately narrow and easily visible under the hand lens.

35. *Hirtella.*

Two species are reported from Porto Rico: *Hirtella tiandra* Sw. (Teta de burra) and *Hirtella rugosa* Pers. (Teta de burra cimarron, Icacillo).

Described as shrubs or small trees ranging from 20 to 50 feet high and from 6 to 12 inches in diameter, occurring throughout the island, chiefly in mountainous regions. The wood is used principally for fuel and charcoal. Wood light brown, turning darker with age, fine and straight-grained, hard, heavy, strong, tough, and moderately durable in the soil.

XIV. LEGUMINOSÆ.

***36.** *Inga vera* Willd. Guava, Gauba.

Tree from 30 to 50 feet high growing in mountainous region and extensively planted for shade in coffee plantations, for which it is considered the most important tree in Porto Rico. Wood used only for fuel and charcoal.

Wood light gray, fine grained, moderately hard, heavy (40 pounds per cubic foot), and strong. Pores small, isolated or in groups of two or three, evenly distributed and sometimes connected tangentially by the wood-parenchyma fibers surrounding each pore. Pith rays minute, inconspicuous.

***37.** *Inga laurina* (Sw.) Willd. Guamá.

Tree from 30 to 50 feet high, abundant in the foothills, and very valuable as a shade tree in coffee plantations, being considered only second to *Inga vera* for this purpose. Wood used for firewood and charcoal.

Wood dark gray, fine-grained, moderately hard, and heavy (44 pounds per cubic foot). Pores small, isolated or in groups of two or three, evenly distributed, and often connected by tangential lines of wood-parenchyma fibers. Pith rays minute very inconspicuous.

*38. *Pithecolobium saman* (Jacq.) Benth. Saman, Guango; Rain tree (Br. W. I.).

Cultivated tree from 45 to 60 feet high, occurring sparingly throughout the island. Native of Central and South America. Excellent for shade in yards and along roadsides, as well as in pastures where through the property of its roots to accumulate and store nitrogen in the soil it is also beneficial to the grass crop. It yields pods very suitable for food for cattle. It is believed to be superior to the bucare (*Erythrina*) as a shade for nutmeg, cacao, coffee, tea, and similar crops because less liable to fall and injure the plantation. It is especially well adapted for planting in dry arid regions. In Central America the wood is used to make wheels for oxcarts.

Wood red, fine-grained, taking a good polish, fairly hard and heavy, not durable. Pores moderately small, isolated or in groups of two to four, evenly distributed surrounded by wood parenchyma which sometimes forms tangential lines. Pith rays small, inconspicuous.

NOTE.—*Pithecolobium arboreum* (L.) Urb. (Cojoba, Cojobana) is reported as being a tree from 45 to 60 feet high and about 18 inches in diameter, occurring in many parts of the island. The structure of the wood is similar to that of *P. saman*.

*39. *Albizzia lebbeck* (L.) Benth. Acacia amarilla, Amor platonico, Flamboyán; East Indian walnut, Siris tree, Woman's tongue (Br. W. I.).

Beautiful cultivated tree from 30 to 40 feet high, drought resisting, and planted in the southern part of the island. Native of the East Indies. Has no economic uses in Porto Rico, but elsewhere the wood is used for house and boat building, furniture, sugar-cane crushers, etc., while the gum, as an adulterant of gum arabic, is used in calico printing.

Wood dark brown, lustrous, and rather cross-grained, resembling our black walnut (*Juglans nigra* L.) in appearance and finish, takes a good polish, seasons and works well, is hard, heavy (about 48 pounds per cubic foot), moderately strong, and durable. Pores small, isolated or in groups of two or three, evenly distributed and more or less surrounded by wood parenchyma. Pith rays small, inconspicuous.

40. *Acacia nudiflora* Willd. Cojoba, Cojobana, Tamarindo cimarron, Acacia nudosa.

Tree from 25 to 50 feet high and about a foot in diameter, with a limited distribution on the east coast. Wood brown, tinged with red, somewhat coarse and straight-grained, taking a good polish. It is hard, heavy, strong, moderately tough, and durable. Pores rather large and arranged in more or less irregular tangential rows visible on smooth transverse surface.

NOTE.—Another species, *Acacia riparia* H. B. K. (Zarza), is reported as quite generally distributed on the island. It attains at times a height of 45 feet and has a wood similar to the above.

*41. *Leucaena glauca* (L.) Benth. Acacia palida, Hediondilla; Ipil-Ipil (Philippine Islands).

Tree from 25 to 30 feet high and sometimes a foot in diameter, quite common throughout the island and tropical America generally. The tree is especially well adapted for reforestation of grassy wastes because of the ease with which it establishes itself in competition with the grass sod and its rapid growth. Wood used locally for making tools, handles, etc.

Wood brownish, tinged with red, rather coarse and straight-grained, taking a good polish. It is hard, heavy, strong, tough, and very durable. Pores rather large, solitary, and evenly distributed. Pith rays very narrow and indistinct.

42. *Adenanthera pavonina* L. Coralitas, Mato, Mato colorado, Palo de mato, Peronilas.

Tree seldom more than 30 feet high, introduced from the East Indies, and growing spontaneously in many places. The wood resembles red sandalwood (*Pterocarpus*) and is used for making a red dye. The seeds when crushed and mixed with borax make an adhesive substance. Wood used for house building and cabinetmaking.

Wood takes a good polish and is hard, heavy, strong, and durable. Pores moderately large, solitary, and surrounded by abundant wood parenchyma, which occasionally forms tangential lines. Pith rays very numerous and inconspicuous.

*43. *Piptadenia peregrina* (L.) Benth. Cojobana, Cojoba, Cojobillo, Cojobo.

Tree about 60 feet in height and about a foot in diameter, quite generally distributed on the island. In central and South America it grows to be a very large tree, yielding valuable timber known as "yoke," but in Porto Rico no uses have been recorded except for fuel and charcoal.

Wood dark reddish-brown, close-grained, hard, heavy, strong, tough, and very durable.

44. *Stahlia monosperma* (Tul.) Urb. Cobana negra, Cóbana, Cóbano, Polisandro.

Tree from 20 to 30 feet high and about a foot in diameter, found chiefly along the coast and watercourses. The wood is much used for making furniture, also for railroad ties for the cane roads. Wood is black, hard, heavy, strong, and tough.

*45. *Hymenæa courbaril* L. Algarrobo, Courbaril, Quapinole jutahy, Jatoba; Locust tree (Br. W. I.).

Tree from 30 to 90 feet high, with a diameter of from 4 to 6 feet, well distributed throughout the island. The wood is used largely for the cogwheels of sugar mills, for wagon wheels, in carpentry, and especially for cabinet work and fine furniture. A resin, known as American copal, resina copal, and courbaril obtained from this tree is used as a medicament and for ornaments. The fruit is sometimes used as food.

Wood, red with light and dark streaks; sapwood lighter, beautiful, somewhat resembling mahogany, very fine grained, capable of a high polish, hard, heavy (about 64 pounds per cubic foot), tough, durable (except when placed underground), and seasons well. Pores moderately small, isolated or in groups of two to four, evenly distributed, surrounded by wood parenchyma, which often connects them tangentially. Annual rings of growth clearly visible. Pith rays small, scarcely visible to the unaided eye on a smooth transverse surface.

*46. *Tamarindus indica* L. Tamarindo; Tamarind (Br. W. I.).

Tree from 20 to 60 feet high, very common throughout the island, and widely cultivated in the Tropics for the acid pulp of its fruit. It is a beautiful ornamental tree, well adapted for roadside planting. Its leaves, bark, seeds, and flowers all have medicinal and other useful properties. Probably native to tropical Africa. The wood is highly esteemed for the handles of tools, as axes and hoes, is sometimes used for building purposes, and is said to furnish excellent charcoal for the manufacture of gunpowder.

Wood light yellow, fine and cross grained, hard, heavy (about 59 pounds per cubic foot), tough, elastic, and very durable. Pores moderately small, isolated or in groups of two or three, evenly distributed, often connected by conspicuous tangential lines of wood parenchyma. Pith rays minute, very inconspicuous.

47. *Bauhinia kappleri* Sagot. Flamboyan blanco, Seplina, Varietal.

Tree from 30 to 50 feet high, introduced from Asia. Grows spontaneously in many parts of the island. Wood used for fuel and sometimes for making small articles of furniture. Wood brownish in color and very handsome, fine grained, and takes a beautiful polish.

*48. *Cassia fistula* L. Cañafistula.

Cultivated tree from 20 to 60 feet high and about a foot in diameter, a native of tropical Asia, and very common over the entire island. Wood is used for fuel, the bark for tanning, and the pulp of the pods medicinally. Wood of a reddish color, hard, heavy (about 60 pounds per cubic foot), strong, tough and durable.

*49. *Cassia grandis* L. Cañafistula cimarrona.

Cultivated tree from 40 to 60 feet high and from 1 foot to 1½ feet in diameter, occurring mostly in the southwestern part of the island, found to some extent in a wild

state. Wood used for carpentry and cabinetwork. Wood reddish-brown, handsome, fine and straight grained, taking a high polish, hard, heavy (about 51 pounds per cubic foot), strong, and durable.

*50. *Hæmatoxylum campechianum* L. Palo de Campeche, Campeche; Logwood.

Tree from 20 to 40 feet high and 6 or more inches in diameter, occurring in the western part of the island chiefly along the coast and throughout tropical America. It is occasionally planted on the island for its wood, the logwood of commerce, which is used in making dyes.

Wood blood red, very fine and cross grained, taking a very high polish, hard, heavy, strong, tough, and very durable.

51. *Poinciana regia* Boj. Flamboyán, Flamboyan colorado; Flame tree (Br. W. I.).

Cultivated tree from 45 to 60 feet high, found mostly in the western part of the island. Native of Madagascar. It is a beautiful ornamental shade tree very common in the West Indies and widely planted throughout the Tropics. Wood little used.

Wood white, moderately fine grained, taking a good polish, but soft, light, and not strong. Pores small, isolated or in groups of two or three, evenly distributed. Tangential lines of wood-parenchyma fibers very prominent. Pith rays minute, very inconspicuous.

52. *Ormosia krugii* Urb. Palo de mato, Mato, Peronia.

Tree from 30 to 80 feet high, with a limited occurrence throughout the island. The wood is used only for charcoal. Wood very light, soft, and inferior.

53. *Sesbania grandiflora* (L.) Pers. Gallito, Báculo, Cresta de gallo.

A tall shrub or small cultivated tree from 10 to 30 feet high, quite generally planted over the island. Probably a native of the East Indies. The wood is used for poles, posts of native houses, and firewood. Parts of the tree are used medicinally and as food. Wood white, soft, light, and not durable. Pores of medium size, isolated or in groups of two to five, evenly distributed. Pith rays small, indistinct.

*54. *Pictetia aculeata* (Vahl.) Urb. (= *P. aristata* P. DC.). Tachuelo, Hachuelo.

Tree from 15 to 30 feet high, found chiefly in the southern and eastern coastal regions. The wood is often used in native house construction for underpinning, shingles, and shelving, and for cabinet work. It becomes with age extremely hard, so that it will turn the edge of almost any woodworking tool. It is somewhat used for fuel, but the charcoal burner avoids it because of the effect upon his ax.

Wood dark brown, fine, and straight grained, taking a very high polish, extremely hard, heavy, strong, tough, lasting almost indefinitely in contact with the soil. Pores rather small and connected by numerous fine tangential lines, which are visible only under a hand lens on a smooth transverse surface.

55. *Pterocarpus officinalis* Jacq. Palo pollo, Palo de pollo.

Tree from 75 to 90 feet high and from 1 foot to 2 feet in diameter, found chiefly in swampy localities in Porto Rico, but more generally distributed in other parts of the West Indies and Central America. Wood is used for fuel.

Wood light brown or rusty colored, fine and straight grained. It does not take a very high polish and is soft, light (about 35 pounds per cubic foot), weak, brittle, and not durable in contact with the soil.

56. *Lonchocarpus.*

This genus is represented in Porto Rico by three species which are of but slight economic importance. *Lonchocarpus latifolius* (W.) H. B. K. (Palo Hediondo, Forte Ventura), a tree occasionally 60 feet high found in many parts of the island. The wood, sometimes used locally for furniture, is reddish with occasional dark or black streaks. *Lonchocarpus domingensis* (Pers.) P. DC. (Geno-geno), and *Lonchocarpus glaucifolius* Urb. (Geno), tree from 15 to 45 feet high with a limited distribution in the western part of the island. Wood used for fuel.

*57. *Piscidia piscipula* (L.) Sarg. Ventura.

Tree often 60 feet high and about 2 feet in diameter. It has a very limited occurrence along the shores of the island. Wood is light yellow-brown, very fine and straight grained, taking a very good polish, hard, heavy (about 54 pounds per cubic foot), strong, tough, and very durable in contact with the ground. Pores rather large, not numerous, and surrounded by softer tissue which is clearly visible in transverse surface as numerous tangential bands.

58. *Andira jamaicensis* (W. Wr.) Urb. Moca, Moca blanca; Cabbage tree (Br. W. I.); Bastard cabbage-bark, Angelin (Jamaica).

Tree from 30 to 60 feet high and from 12 to 30 inches in diameter, quite generally distributed in the forests throughout the island. The wood is very suitable for piles, bridges, boat construction, the hubs of wheels, flooring, and all kinds of carpentry work. Its most common use in Porto Rico is for the framework of country houses. The wood is imported into Europe and this country for walking sticks and umbrella and parasol handles and for the turned parts of cabinetwork.

Wood reddish-yellow with dark streaks, cross and coarse-grained, capable of a high polish, hard, heavy (from 47 to 55 pounds per cubic foot), strong, tough, and especially durable in water. Pores moderately large, isolated or sometimes in groups of two to four, evenly distributed, and connected by tangential branching lines of wood-parenchyma fibers. Pith rays narrow, indistinct.

59. *Erythrina.*

A genus represented in Porto Rico by two native and one introduced species. Of the native species *Erythrina corallodendron* L. (Bucare, Piñon espinoso; Red bean tree [Jamaica]; Coral wood, Arbol madre [Mexico]) is a shrub or small tree from 10 to 20 feet high, found chiefly on limestone hills, while *Erythrina glauca* Willd. (Bucago) is from 30 to 40 feet high, with a limited occurrence, usually along rivers. Both species occur quite generally throughout tropical America. Their wood is made into corks, floats for fishing nets, light ladders, etc., and is light in color, coarse-grained, corky, soft, light, and weak. Pores of medium size, isolated or in groups of two or three, evenly distributed. Pith rays easily distinguishable on a smooth transverse surface. *Erythrina micropterya* Poepp. (Bucare, Palo de boyo; Bois immortelle, Madre de cacao [S. Am.]) is a tree from 45 to 60 feet high, cultivated in many localities on the island, mostly on coffee plantations, for its shade. Indigenous in Peru. Wood soft, similar to the other two species.

XV. Zygophyllaceæ.

*60. *Guajacum officinale* L. Guayacán, Lignum-vitæ.

Tree from 30 to 60 feet high and from 12 to 18 inches in diameter, occurring chiefly along the southern coast. The wood is highly esteemed for its wearing qualities, and is widely used for pulleys, rollers for casters, wooden cogs, mortars, hubs for wheels, and wherever great strength and hardness are required.

Wood dull yellowish-brown with dark olive-brown streaks, very fine, close and cross grained, greasy to the touch, takes a fine polish, and is extremely hard and heavy (about 85 pounds per cubic foot), very tough, and durable. Pores minute, isolated, and easily distributed. Pith rays minute and very inconspicuous.

Note.—Another species said formerly to have been abundant by now of only limited occurrence along the south coast is *Guajacum sanctum* L. (Guayacán blanco, Guayacancillo), a shrub or tree from 30 to 45 feet high, having a wood similar to that of the preceding.

XVI. Rutaceæ.

61. *Fagara*[1] *martinicensis* Lam. Cenizo, Espino, Espino rubial, Ayua; Prickly ash (Br. W. I.).

Tree from 40 to 80 feet high and from 1 foot to 3 feet in diameter, found in the mountain forests throughout the island. The wood is used for furniture and cabinetwork and also for house building. The bark contains a dye.

[1] *Fagara=Zanthoxylum.*

Wood[1] light yellow, fine and straight grained, taking a very beautiful polish, hard, heavy (60 pounds per cubic foot), strong, somewhat brittle, and not considered durable for outside work. Pores small, solitary or sometimes grouped in twos and threes. Pith rays very narrow and scarcely visible under the hand lens.

*62. *Fagara flava* (Vahl.) Kr. et Urb. Satinwood, Yellow wood (Br. W. I.).

Tree from 10 to 30 feet high and from 10 to 12 inches in diameter with a limited distribution in the southwestern part of the island. The wood is used for veneering, cabinetwork, and furniture. It is too valuable for structural purposes. It was formerly exported as a substitute for the true satinwood (*Chloroxylon swietenia* DC.) of India.

Wood light yellow, but darkening with age. It has a satiny luster on a longitudinal surface, where it shows when polished a beautiful rippled pattern. It is hard, heavy (about 60 pounds per cubic foot), strong, and moderately tough. Structure of wood similar to the preceding.

NOTE.—Other species of this genus in Porto Rico are *Fagara caribæa* Krug et Urb. (Espino Rubial), a tree from 30 to 60 feet high; *Fagara monophylla* Lam. (Carubio, Mapurito, Rubia, Espino, Espino Rubial); and *Fagara trifoliata* Sw. (Espino Rubial), trees from 10 to 30 feet high, each commonly occurring in the foothills and south coast regions.

63. *Ravenia urbani* Engl. Tortugo Prieto.

Tree from 30 to 50 feet high, of rare occurrence, reported only from the high forest region of the Sierra de Luquillo.

64. *Amyris maritima* Jacq. Tea, Palo de tea.

Tree from 15 to 30 feet high and from 4 to 8 inches in diameter, growing in thickets near the sea. It is very suitable for furniture, and splinters are used as torches by the natives. It is especially useful in exposed situations.

Wood light yellow, with a spicy odor, very fine-grained, and oily to the touch. It takes a fine polish and is hard, heavy, strong, and durable. Pores minute, isolated or in groups of two to twelve, sometimes more, evenly distributed. Pith rays very small and inconspicuous.

*NOTE.—Another species of but slight importance in Porto Rico is *Amyris balsamifera* L. (Tea; rosewood or torchwood [Jamaica]), a tree from 15 to 20 feet high, with whitish wood very similar in properties and uses to *A. maritima*.

*65. *Citrus aurantium* L. China dulce, Naranja China; Sweet orange (Br. W. I.).

A cultivated tree from 15 to 40 feet high and occasionally nearly a foot in diameter. A native of southern Asia, it has been widely introduced throughout the Tropics. It is planted everywhere on the island and to some extent grows spontaneously. The wood is much used for making walking sticks, in cabinetwork, and for knickknacks of various sorts. The fruit varies widely in quality and size, but the best of it is heavy and juicy and has a fine flavor.

Wood light yellow, close and straight grained, taking a beautiful polish, hard, heavy (about 55 pounds per cubic foot), very strong, tough, and durable. Pores very small, numerous, and more or less evenly distributed. Numerous fine tangential lines of soft tissue visible on a smooth transverse surface under the hand lens. Pith rays very narrow, numerous, and inconspicuous.

NOTE.—The principal horticultural varieties also cultivated for their fruit, some of which are to be found growing in the semiwild state, are: *Citrus bigaradia* Loisel (Naranja; Sour orange [Br. W. I.]); *Citrus decumana* L. (Toronja, Pomelo, Grapefruit); *Citrus hystrix*, subsp., *acida* (Roxb.) Bonavia (Lima, Lime); *Citrus limonum* Risso (Limón, Lemon); *Citrus medica* L. (Toronja, Cidra, Citron, Citrus limetta, Bergamota, Limon dulce, Sweet lemon).

[1] See pp. 10 and 11, Forest Service Circular 184, "Fustic Wood: Its Adulterants."

XVII. Simarubaceæ.

***66.** *Simaruba tulæ* Urb. Aceitillo; West Indian satinwood (Br. W. I.).

Tree from 20 to 50 feet high and from 12 to 18 inches in diameter, occurring in mountain forests from the Luquillos to Maricao. It is reported formerly to have been plentiful on the limestone uplands north of Lares, in association with moralon and capa blanca, and to have been cut into lumber for building purposes. Now so scarce as to be no longer of any importance. Elsewhere in tropical America it is considered one of the rarest and most expensive ornamental woods for furniture and interior finish, being so much sought after that the stumps are often dug up and cut into veneer.

Wood light yellow, very fine, and often wavy-grained, taking a high polish, hard, heavy (about 55 pounds per cubic foot), strong, and durable. Pores small, isolated or in groups of two or three, evenly distributed. Pith rays narrow, not visible to the unaided eye.

67. *Picramnia pentandra* Sw. Guarema, Hueso, Hueso prieto, Palo de hueso.

Tree from 15 to 35 feet high and from 15 to 25 inches in diameter, occurring quite generally on the island. Wood used in house building.

Wood dark colored, fine grained, taking a good polish, hard, and very heavy (about 76 pounds per cubic foot). Pores small, isolated or in groups of two or three, evenly distributed. Pith rays narrow, inconspicuous.

XVIII. Burseraceæ.

68. *Tetragastris balsamifera* (Sw.) O. Kuntze. Masa, Masa colorado, Palo de aceite, Palo de masa; Copal (Guatemala).

A common forest tree from 20 to 70 feet high and from 16 to 20 inches in diameter, found in the mountainous parts of the island. This tree yields a very desirable wood for interior work of houses.

Wood rose-colored or yellowish, beautiful, fragrant, and fine-grained, moderately hard, light, strong, and very durable. Pores small, isolated or in groups of two to four, evenly distributed. Pith rays small, inconspicuous.

69. *Dacryodes excelsa* Vahl. Tabanuco, Tabonuco; Candle wood (Br. W. I.).

A tree from 60 to 75 feet high and from 3 to 5 feet in diameter, found quite generally in the mountainous regions, especially in the Luquillos, where it often occurs in large stands. One of the most valuable trees on the island for lumber, because of its large size, straightness of bole, and occurrence in close, pure stands. A resin obtained from the gum is used extensively by the natives for candles and torches, as incense, and medicinally. The wood is used for flooring, ceiling, etc., and is often stained and sold as mahogany.

Wood brown, sometimes cross and fine grained, often giving a "satiny" appearance. It is similar in physical properties to our yellow poplar (*Liriodendron tulipifera* L.), lumber dealers of this country placing them in the same class. Tabanuco is, however, handsomer and finer grained than yellow poplar and capable of a higher polish. It is moderately hard, heavy, strong, and not durable when exposed. Pores small, solitary, or in groups of two or two or three, and evenly distributed. Pith rays small, inconspicuous.

***70.** *Bursera simaruba* (L) Sarg. (=*B. gummifera*, Jacq.). Almácigo; Gumbo limbo, West Indian birch (Br. W. I.).

Tree from 20 to 40 feet high, very common on the island. This is the largest tree of the chaparral forests on the limestone hills of the south side of the island. Like the jobo (*Spondias lutea*), it is readily propogated from cuttings, even from stakes of large size. It is therefore used for "live" fence posts and is one of the commonest trees to be seen along the roadside, where it also serves, though poorly, for the purpose of shade. The wood is of little value.

Wood light brown, often with dark discolorations, fine grained, very soft, spongy, light, weak, and very liable to decay. Pores numerous, small, isolated or in groups of two or three, sometimes more. Pith rays very inconspicuous.

XIX. Meliaceæ.

***71.** *Cedrela odorata* L. Cedro, Cèdro hembra; West Indian cedar; Spanish cedar; Cigar-box cedar (Br. W. I.).

Tree from 50 to 100 feet high and from 4 to 6 feet in diameter, formerly common to all parts of the island, but now rare except in the inaccessible places. Spanish cedar is one of the most highly esteemed woods in the West Indies and is used for more purposes than any other. Its principal use, however, is for cigar boxes.

The wood is pale reddish-brown, but varies considerably from very light to very dark, depending upon the age and the kind of soil in which it grows. It has a general appearance similar to that of mahogany and possesses a characteristic fragrant odor. It is moderately soft, light (about 30 pounds per cubic foot), rather strong, somewhat tough, and very durable in contact with the soil. Pores are rather large, not numerous, solitary, or often in small groups distributed evenly throughout the wood. Pith rays few, narrow, and indistinct to the naked eye.

***72.** *Swietenia mahagoni* Jacq. Caoba; Mahogany (Br. W. I.).

Tree from 50 to 100 feet high and from 3 to 5 feet in diameter. This tree has not been reported from Porto Rico by recent botanical explorers. There is some evidence, however, that mahogany occurred at one time on the island. It is the most highly esteemed wood for furniture and interior finish. No other wood has such a wide range of uses and so many substitutes.

Wood light or dark brown, with a very pleasing appearance when polished. It is fine and cross grained, works rather easily, hard, heavy (varies from 35 to 67 pounds per cubic foot), strong, tough, and very durable. Pores are moderately large, often filled with white or brown substance (tyloses), and arranged singly or in small groups; pith rays inconspicuous to the unaided eye.

***73.** *Melia azedarach* L. Alilaila, Lilaila, Pasilla; China berry (Br. W. I.)

Tree from 20 to 50 feet high and from 8 to 15 inches in diameter, cultivated and growing spontaneously in various parts of the island, including the Cordillera Central and the limestone formation of the western and southwestern coast. This tree has been introduced from Asia and is now very common throughout tropical and subtropical parts of the world for shade and ornament. The wood is sometimes used by the country people for tool handles and the like.

Wood mahogany colored, with a coarse and straight grain, moderately soft, light, weak, and not durable in contact with the soil. Pores rather large in early wood, which render the boundary of the annual rings of growth usually very conspicuous; the pores in the late wood are much smaller and inconspicuous.

*Note.—An umbrella variety of the alilaila, *Melia azedarach umbraculifera* Sarg. (Umbrella China tree, China berry (Br. W. I.), which was developed in Texas in about 1880, is planted in Porto Rico merely for shade and ornament. The wood has characteristics similar to the one above.

***74.** *Guarea trichilioides* L. Guaraguao, Acajou; Musk wood (Br. W. I.).

Tree from 40 to 80 feet high and sometimes 6 feet in diameter. It occurs in mountain forests from the Luquillos to Maricao and is one of the leading woods of the island, being very highly prized by the natives. Because of the great demand it is now rather scarce. Its principal uses locally are for strong wagons and carriages, farm implements, and general carpentry. The wood resembles mahogany and Spanish cedar and is useful for the same purposes.

Wood light reddish-brown, sometimes streaked with lighter and darker shades, hard, moderately heavy, strong, tough, and very durable in contact with the soil. It has in a general way the appearance of dark-colored mahogany and an odor resembling musk. Pores small, very numerous, and connected by fine tangential lines of softer tissue which are scarcely visible to the unaided eye. Pith rays very narrow, numerous, and inconspicuous.

*Note.—Another and little-known species of this genus is *G. ramiflora* Vent. (Guaraguaillo, Guaraguao macho), a tree usually under 25 feet and rarely

60 feet high, occurring in the forests, widely distributed, but not plentiful, throughout the uplands from the Luquillos to Mayaguez. Wood similar to the one above.

75. *Trichilia.*

Three species of this genera occur in Porto Rico: *Trichilia pallida* Sw. (Caracolillo, Gaita, Ramoncillo, Cabo de hacha); *Trichilia hirta* L. (Cabo de hacha, Guaita, Jobillo, Molinillo, Palo de anastasio, Retamo, Guayavacón); and *Trichilia triacantha* Urb., trees from 15 to 60 feet high, occurring principally in the mountainous regions of the island and to some extent in the limestone hills of the south coast. Wood, though very similar to that of *G. trichilioides*, is seldom used except for fuel.

XX. Malpighiaceæ.

***76.** *Byrsonima spicata* (Cav.) L. Cl. Rich. Maricao.

Tree from 20 to 60 feet high and from 18 to 24 inches in diameter, occurring quite generally in forests throughout the island. The wood is used for furniture and house building. The bark is astringent and is used for tanning.

Wood dull reddish brown, moderately fine grained, taking a good polish, moderately hard, heavy, and strong. Pores small, isolated or in groups of two or three, evenly distributed. Pith rays narrow, inconspicuous.

***77.** *Byrsonima lucida* (Sw.) L. Cl. Rich. Palo de doncella, Sangre de doncella.

Tree from 20 to 30 feet high, quite widely distributed on the island. The wood is highly esteemed for furniture and interior finish. Wood dark brown, very fine grained, taking a good polish, moderately hard, heavy, and strong. Pores minute, isolated, or in groups of two or three, evenly distributed. Pith rays very narrow and inconspicuous.

XXI. Euphorbiaceæ.

78. *Phyllanthus.*

Two species of this genera are found in Porto Rico, one a native (*Phyllanthus nobilis* var. *antillanus* (Juss.) Müll. (Amortiguado, Avispillo, Higuerillo, Higuillo, Millo, Palo de millo, Siete-cueros [mas.], Yaquillo [fem.]) is a tree from 30 to 60 feet high, widely distributed on the island; the other *Phyllanthus distichus* (L.) Müll. (Grosella, Grosella blanca, Cerezas, Cereza amarilla, Otaheite gooseberry), introduced from India, is a tree from 15 to 30 feet high, cultivated for the sake of its fruit. Wood of both is but little used, although very beautiful, white, hard, strong, and tough.

***79.** *Drypetes lateriflora* (Sw.) Kr. et Urb. Varital; Florida or Guiana plum, White-wood (Br. W. I.).

Tree from 20 to 30 feet high and from 5 to 10 inches in diameter, found principally near Bayamon. It is also common in southern Florida and on the islands of the West Indies. Wood rich dark brown, very fine and cross grained, hard, heavy (about 58 pounds per cubic foot), not strong, brittle, and liable to check in drying. Pores small, solitary, or in short radial rows, with numerous very fine tangential lines of softer tissue present. Pith rays very numerous and inconspicuous.

80. *Drypetes alba* Poit. Cafeillo, Hueso, Palo de vaca blanco.

Tree from 15 to 60 feet high found in the mountain forests of the Sierra de Luquillo and Cordillera Central. The wood is often used for hubs of wheels, and also for fuel and charcoal.

Wood light yellow, with irregular, thin, yellowish-brown streaks, fine and cross grained, taking a high polish, hard, moderately heavy, strong, tough, and difficult to split. Pores rather small, solitary or in short interrupted radial rows, evenly distributed. Pith rays very narrow, but plainly visible on a smooth surface under the hand lens.

Note.—Another species of this genera of slight importance, yielding a wood of inferior quality which is seldom used except for fuel and charcoal, is *Drypetes glauca* Vahl. (Palo blanco, Cafeillo, Varital, Palo de aceituna), a tree from 20 to 50 feet high and from 1 to 2 feet in diameter, generally distributed throughout the mountain forests and somewhat in the woodlands along the south coast. It is also common throughout a number of the islands of the West Indies. The wood is of inferior quality.

81. A group of unimportant genera of this family, each represented by a single species, comprises *Hieronymia clusioides* (Tul.) Mull. (Cedro macho), a tree from 45 to 100 feet high, occurring in the western parts of the island. Native also to other of the West Indies. There are no recorded uses for the wood nor descriptions of its characteristics. *Alchorneopsis portoricensis* Urban. (Palo de gallina), tree from 30 to 50 feet high, known only from the Luquillo, and central regions of the island. It yields a soft wood of little use. *Alchornea latifolia* Sw. (Achiotillo, Palo de cotorra, Yobillo), a tree from 25 to 60 feet high, quite widely distributed, yielding a wood with properties similar to that of Palo de gallina. *Sapium laurocerasus* Desf. (Hinchahuevos, Lechesillo, Manzanillo, Tabeiba), a tree from 15 to 50 feet high, widely distributed in mountainous regions on the island.

*82. *Aleurites moluccana* (L.) Willd. (= *A. triloba* Forst.). Nuez, Nuez de India; Candleberry tree, Candlenut, Indian walnut (Br. W. I.).

Tree from 20 to 40 feet high. Introduced from tropical Asia and the South Sea Islands and planted here and there throughout Porto Rico. It is useful mainly for shade throughout the Tropics and for the nuts it bears, which are called "kukui" nuts in the Sandwich Islands. Wood little used.

Wood very light yellow, soft, light, weak, and not durable in contact with the soil. Pores small, isolated or in groups of two to five, radially disposed, and evenly distributed. Pith rays minute and very inconspicuous.

*83. *Hippomane mancinella* L. Manzanillo, Machineel.

Tree from 15 to 50 feet in height, occurring in the coastal regions. It has a poisonous acid sap which necessitates considerable care being taken in felling and in thoroughly seasoning the wood before working. The wood is suitable for furniture and is used largely for veranda floors and weatherboarding because of its durability when exposed.

Wood yellowish brown, with darker stripes, beautiful, slightly fragrant, straight and very fine grained, resembling in general appearance and texture the boxwood of commerce (*Buxus sempervirens* L.). It takes a high polish, is hard, varies from light to heavy (from 36 to 50 pounds per cubic foot), strong, tough, very durable, and very easy to work; in all these qualities this wood resembles mahogany. The pores are minute, numerous, solitary, and evenly distributed. Pith rays minute, scarcely visible to the unaided eye on a radial surface.

84. *Hura crepitans* L. Javillo, Molinillo, Havillo, Havarilla; Sand-box tree, Monkey's dinner bell (Br. W. I.).

Tree from 20 to 50 feet high and from 1 foot to 2½ feet in diameter, introduced from South America. It is planted extensively throughout the island for shade, because of its spreading crown. The acid irritant sap necessitates careful felling and seasoning of the wood before working. The wood is valued locally for making canoes and for interior work in houses. In some parts of the West Indies the trunks are often hollowed and used extensively for holding cane sugar.

Wood very light brown, with darker brown stripes, fine and straight grained, taking a fine polish. It is soft, light (about 31 pounds per cubic foot), extremely brittle, and is said to resist the action of water. Pores very small and evenly distributed throughout the annual rings of growth. Pith rays very inconspicuous.

XXII. Anacardiaceæ.

*85. *Mangifera indica* L. Mango.

A cultivated and sparingly naturalized tree from 30 to 50 feet high and from 12 to 18 inches in diameter, native of southern Asia or the Malay Archipelago. It yields a very common but highly prized fruit of the Tropics, comparable in quality and value with the apple or the orange, though entirely different from either in texture and flavor. The wood is useful for the same purposes as our common ash (*Fraxinus*), gunstocks, tool handles, window frames, etc.

Wood grayish brown, fine grained, hard, heavy (about 50 pounds per cubic foot), strong, tough, and elastic. Pores small, isolated or in groups of two to four, evenly distributed. Pith rays narrow, inconspicuous.

86. *Anacardium occidentale* L. Pajuil, Cajuil, Acaju, Marañón; Cashew tree (Br. W. I.).

A wild and cultivated tree from 20 to 40 feet high and from 9 to 12 inches in diameter, occurring in all parts of the island. It is used largely in boat building, for carriage hubs, yokes, and farm utensils. Its principal use in Porto Rico is for charcoal and fuel. The nuts are edible when roasted, and yield oils which are useful for many purposes. An acrid irritant substance contained in the soft shell of the nuts necessitates care in handling them. This is driven off as poisonous fumes in roasting.

Wood pinkish, fine grained, hard, moderately heavy (about 36 pounds per cubic foot), strong, and durable. Pores small, isolated or in groups of two to four, evenly distributed. Pith rays small, inconspicuous.

87. *Spondias mombin* L. (=*S. lutea* L.). Jobo; Hog plum (Br. W. I.).

Tree from 30 to 40 feet high and from 1 foot to 2 feet in diameter. Very common throughout the island, particularly along roadsides. It is much used for stakes and fence posts, which are very durable because they take root and live. It is probably due to this property, as with the almacigo (*Bursera simaruba*), more than to any specially favorable quality as a shade tree that they are so commonly found along roadsides. It is one of the trees commonly pollarded for fuel wood and bears an edible fruit which is much esteemed.

Wood yellowish brown, fine grained, soft, light (about 30 pounds per cubic foot), and moderately strong. Pores small, isolated or in groups of two or three, evenly distributed. Pith rays minute, very inconspicuous.

88. *Spondias purpurea* L. Ciruela, Ciruela del pais, Jobillo, Jobo frances; Spanish plum (Br. W. I.).

A tree or shrub from 20 to 30 feet high, occurring in mountainous regions. It is often cultivated for its fruit, which is considered superior to *S. mombin*. Wood in all respects similar to *S. mombin*.

89. *Metopium toxiferum* (L.) Krug. et. Urb. Cedro prieto, Papayo; Poison wood, Hog plum (Br. W. I.).

Tree from 30 to 50 feet high, with a short trunk sometimes 2 feet in diameter. It has a limited distribution in the southwestern part of the island, and occurs throughout the West Indies and on the keys of southern Florida.

Wood rich, dark brown streaked with red, fine and straight grained, resembling the wood of our native sumacs. It takes a fine polish, is easily worked, moderately hard, heavy (about 50 pounds per cubic foot), not strong, and only moderately tough. Pores small, very numerous, and evenly distributed throughout the wood. Pith rays very narrow and inconspicuous.

XXIII. Aquifoliaceæ.

90. *Ilex nitida* (Vahl.) Maxim. (=*I. dioica* Griseb.) Cuero de sapo, Brigueta naranjo, Hueso prieto, Palo de hueso.

Tree from 20 to 60 feet high and from 10 to 15 inches in diameter, occurring in the mountain forests of the Luquillo region and generally throughout the island. The wood is used for fuel and for hut building. Wood light-colored, fine-grained, hard, and heavy.

91. *Ilex sideroxyloides* var. *occidentalis* (Macf.) Loes. Gongolin; Central American oak (Br. W. I.).

Tree from 30 to 50 feet high, occurring in the mountain forests of the Luquillo region. Wood of little use. Wood flesh-colored, hard, and heavy.

XXIV. Celastraceæ.

92. *Elæodendron xylocarpum* var. *corymbosum* (Vahl.) Urb. Cocorron, Coscorron, Guayarote.

Shrub or tree from 10 to 30 feet high, occurring quite generally along the seacoasts of the island. Wood fine-grained. Pores minute, isolated, or in groups of two or three, evenly distributed. Pith rays moderately narrow but conspicous.

XXV. Staphyleaceæ.

93. *Turpinia paniculata* Vent. Avispillo, Cedro hembra, Eugenio, Lilaililla, Sauco cimarron.

Tree from 30 to 60 feet or more high, occurring in the mountains and waste places. The wood, which is used for fuel and charcoal, is somewhat similar to that of out bladder nut (*Staphylea trifolia* L.).

XXVI. Sapindaceæ.

94. *Thouinia striata* Radlk. Ceboruquillo, Guara, Quiebra hacha, Seburoquillo.

Tree from 25 to 65 feet high, occurring generally throughout the island, usually in the drier situations. No uses are reported for the wood, doubtless because of its extreme hardness.

Wood light-colored, very fine-grained, with many fine light lines, giving a pleasing figure. It takes a fine polish and is extremely hard, heavy, strong, and tough. Pores minute, isolated, or in groups of two or three, evenly distributed. Pith rays minute, inconspicuous.

95. *Melicocca bijuga* L. Guenepa, Quenepas; Genip tree, Genipe; Ginep (Br. W. I.).

A cultivated and semiwild tree from 25 to 60 feet high and up to 3 feet in diameter reported from the east, south, and west parts of the island. It is native of tropical America and is found throughout the West Indies. It is cultivated somewhat for its fruit and is also suitable for ornament and for roadside shade. Wood is said to be heavy and hard and useful for all purposes except in exposed situations. No local uses are reported.

***96.** *Cupania.*

There are two species of this genera represented in the tree flora of Porto Rico, namely, *Cupania americana* L. (Guara, Guara blanca), and *Cupania triquetra* A. Rich. (Guara).

Trees from 30 to 60 feet high, quite widely distributed locally, and occurring generally throughout the West Indies. The woods of all are alike and are used largely for posts.

Wood very light brown, with a conspicuous wavy grain. It takes a high polish, is soft, moderately light, and brittle. Pores solitary or in groups of two or three, evenly distributed. Pith rays minute, very inconspicuous.

***97.** *Matayaba domingensis* (DC.) Radlk. Doncella, Tea cimarrona, Raton.

Tree from 30 to 60 feet high and from 8 to 10 inches in diameter, occurring chiefly in Luquillo and central mountain regions. It is found also in the other Greater Antilles. No local uses for the wood are reported.

Wood red, fine and straight grained, taking a beautiful polish and resembling dark-colored mahogany. It is hard, heavy, strong, tough, and very durable. Pores rather large, solitary, and evenly distributed; pith rays are narrow and more or less indistinct except under the hand lens.

> Note.—Another species *Matayaba apetala* (Macf.) Radlk. (Doncella) is also reported from the same localities. Size and uses are not noted, although in Jamaica it is reported as attaining a height of from 40 to 60 feet and a diameter of 2½ feet and as being a most useful hardwood, suitable for all purposes and especially for exposed situations.

98. *Exothea paniculata* (Juss.) Radlk. (=*Hypelata paniculata* Camb.). Guacáran, Gáita.

Tree from 20 to 30 feet high and from 12 to 18 inches in diameter, occurring in the limestone hills of the western part of the island. Wood used occasionally for cabinet work. Wood white, moderately hard, heavy, and strong.

XXVII. Sabiaceæ.

99. *Meliosma.*

Two species of this genus occur in Porto Rico: *Meliosma obtusifolia* Krug. and Urb. (Guayrote arroyo, Aguacatillo, Cacao bobo, Cacaillo, Ciralillo, Serillos), and *Meliosma herbertii* Rolfe. (Aguacatillo, Cacao bobo). Trees from 30 to 60 feet high, generally

distributed throughout the mountainous interior from the Luquillos to Maricao and Anasco. Reported also from several other of the West Indies. No local uses for the wood are reported. Pores of wood small, isolated, or in groups of from two to eight or more. Pith rays small, inconspicuous.

XXVIII. Rhamnaceæ.

100. *Colubrina ferruginosa* Brongn. Abelluello, Abejuelo, Achiotillo, Aguacatillo, Aguaytarán, Guitaran, Quitaran, Mabi, Raton, Sanguinaria; Snakewood, Ironwood, West Indian greenheart (Br. W. I.).

Tree from 30 to 60 feet high and sometimes 2 feet in diameter, quite generally distributed throughout the island. The wood is used for building and occasionally for piling on account of its resistance to decay in water.

Wood light yellowish-brown, very fine and wavy-grained, taking a very good polish, very durable in contact with the soil, hard, heavy (about 60 pounds per cubic foot), strong, and tough. Pores very small, somewhat more numerous in the early wood than in the late wood. Pith rays very narrow and inconspicuous.

*Note.—Another species of little economic importance is *Colubrina reclinata* (l'Hér.) Brongn. (Mabi, Palo mabi), a tree 15, rarely 30, feet high from the southwestern part of the island. Wood similar to the preceding.

XXIX. Eloæcarpaceæ.

101. *Sloanea berteriana* Choisy. Cacao motilla, Cacao otillo, Cacao roseta, Cacaillo, Motillo.

Tree from 25 to 90 feet high and sometimes over 2 feet in diameter, occurring chiefly in mountain forests. The wood is used locally for fuel and building purposes.

Wood white, taking a high polish, very hard, heavy, strong, tough, and very durable in exposed situations.

XXX. Malvaceæ.

***102.** *Hibiscus tiliaceus* L. (=*Hibiscus elatus* Sw.=*Paritium tiliaceum* A. Juss.) Emmajaqua, Emajagua, Majagua, Mahagua; Blue or mountain mahoe (Br. W. I.); Mahot, Mahot franc (Haiti); Hau (Hawaii).

Tree from 10 to 30 feet high, growing in moist situations, widely distributed throughout the uplands of the island. Common also in the other West Indies and throughout the remaining tropical world. The bark furnishes a strong and flexible fiber comparable to jute, which is often used in making cordage. Nearly all the ropes in Porto Rico are made from this tree. It has also been highly recommended as a raw material for paper making. The wood makes handsome furniture, cabinetwork, and flooring, and is used largely for shingles and railway sleepers.

Wood dark bluish green, with dark and light streaks, (about 47 pounds per cubic foot), straight and fine-grained, taking a fine polish, hard, heavy, beautiful when polished, strong, tough, and very durable. Pores small or in groups of two or three, evenly distributed. Pith rays minute, inconspicuous.

103. *Thespesia populnea* (L.) Soland. Emajaguilla, Palo de Jaqueca, Santa Maria.

Tree from 30 to 60 feet high, occurring on the north and west coasts in moist situations. It is a common tree on the seashore of most eastern tropical countries and throughout the West Indies. The inner bark of the young branches yields a tough fiber which is used for cordage. The wood is little used locally, but elsewhere in the Tropics is used for cabinetwork, building, and a variety of other purposes.

Wood dark brown, tinged with red, beautiful, "satiny," fine-grained, resembling in general appearance our black walnut (*Juglans nigra* L.). It is hard, heavy, tough, and very durable, especially in water. Pores small, solitary, or in groups of two or three, evenly distributed. Pith rays moderately narrow, distinct, clearly visible on a polished radial surface, where they appear as light flecks and give a pleasing appearance.

*104. *Thespesia grandiflora* P. DC. Maga, Magar, Magas.

Tree from 30 to 45 feet high and from 1 to 3 feet in diameter, occurring quite generally throughout the island. The wood is highly esteemed for furniture, flutes, guitar pegs, etc. It is also used largely for shelving and for foundations, house piling, etc., because of its durability in the ground.

Wood rich chocolate-brown, beautiful, fine-grained, taking a good polish, hard, heavy (42 pounds per cubic foot), strong, and very durable in contact with the soil. Pores solitary or occasionally in groups of two or three, evenly distributed. Pith rays inconspicuous.

XXXI. Bombacaceæ.

*105. *Ceiba pentandra* (L.) Gaertn. (=*Eriodendron anfractuosum* DC.). Ceiba; Silk-cotton, Cotton tree, Kopak tree, Cork wood (Br. W. I.); Fromager (Haiti).

Tree from 60 to 100 feet high and sometimes from 8 to 10 feet in diameter, most common in the south and west coast regions, particularly on limestone soils. It is also widely distributed throughout the Tropics and usually present in open plains and cultivated fields. The wood is used for making boats, dugouts, rafts, tubs, and basins. Boards and shingles are often made of this wood after treating it by immersing the logs in limewater. In West Africa its chief commercial value lies in the "floss" or "kopak"[1] as it is known to commerce, which is a cottony substance surrounding the seeds.

Wood white or light brown, coarse and straight-grained, very soft, light (about 28 pounds per cubic foot), rather strong, and not durable in contact with the soil. Pores large, evenly distributed throughout the annual rings of growth; the latter are not always clearly marked. Pith rays conspicuous.

106. *Quararibea turbinata* (Sw.) Poir. Garrocha, Garrocho, Palo de Garrocha.

A shrub or tree from 25 to 30 feet high, common in all parts of the island.

*107. *Ochroma lagopus* Sw. Guano, Corcho; Bois Liege (Haiti); Cork wood, Down tree (Jamaica); Balsa wood (of commerce).

Tree from 30 to 60 feet high and 1 foot or more in diameter common on the limestone soils and along the shore directly behind the mangrove in the north and west coast regions and generally throughout the south coast and south slopes of the Central Mountains. Particularly common along the roads. It is a tree of the open country, like the ceiba. The wood, because of its extreme lightness, is sometimes used as a substitute for true cork, for stopping bottles, as floats for fish nets, and for other purposes where a light wood is required. The bark yields a chestnut-brown fiber suitable for rope making, and the seed envelopes yield a soft cotton or down extensively used for stuffing pillows and mattresses and to a limited extent for making into garments. The bark is also used locally for the tannin it contains, and both bark and roots are used medicinally.

The wood is nearly white or slightly tinged with red, showing practically no distinction between heartwood and sapwood. It has a silky texture, loose structure, and soft tissue easily compressible under the thumbnail, and is very fibrous and difficult to work. It is said to be the lightest of all woods, having a specific gravity varying

[1] This floss of the ceiba is exported in large quantities from the East Indies and West Africa; the variety from Java is regarded as a fiber of great merit, and is used for stuffing pillows and sofas. Its lightness, softness, and elasticity render it superior to the best qualities of feathers, wool, or hair. This material has been employed also as a buoyant material for packing life belts and for making hats and bonnets, and has even been suggested for the manufacture of paper and guncotton. It is too short in staple and too weak to be spun into yarn. Unfortunately the silk cotton from the West Indies is accounted of little value at present, but it only remains for some one to start its collection here and ship it to American markets. It has been estimated that the average yield of silk cotton from a single tree in the West Indies and Mexico is approximately 100 pounds. Many thousands of bales of silk cotton might be collected annually in the West Indies and turned to economic use. In 1907 a little over 20,000,000 pounds of silk cotton was exported from Java and Sumatra, and of this quantity about 3,000,000 pounds were consumed in the United States for a great variety of purposes.

from 0.120 (or about 7½ pounds per cubic foot) to 0.240. Pith rays quite conspicuous on a transverse section; they are also plainly visible on the radial surface and give figure to the wood, resembling the character of beech or sycamore, only they are more numerous.

*108. *Theobroma cacao* L. Cacao.

A cultivated and seminaturalized tree from 12 to 30 feet high occurring locally on the north and west sides of the island. It is native to tropical America and is grown commercially in a number of the West Indies. It is said to grow best under thoroughly tropical conditions of moisture and warmth at or near sea level (below 500 feet). It is commonly grown under the shade of some one of the leguminous trees, usually *Erythrina micropteryx* (or *E. umbosa*).

XXXII. Sterculiaceæ.

*109. *Guazuma ulmifolia* Lam. (=*Guazuma guazuma* Cock). Guácima, Guácima del norte; West Indian elm, Guazuma plum (Br. W. I.).

Tree from 30 to 60 feet high and from 15 to 18 inches in diameter, very common throughout the island, the Antilles generally, and on the continent. Wood used for oars, posts, staves, fuel, and charcoal.

Wood light grayish-brown, fine and straight-grained, rather soft, light (35 pounds per cubic foot), moderately weak but tough. Pores small, solitary or in groups of two or three, rarely more, evenly distributed. Pith rays distinct, but rather inconspicuous, plainly visible on a smooth radially cut surface.

110. *Guazuma tomentosa* H. B. K. Guácima, Guácima del sur; Bastard cedar (Br. W. I.); Orme d'Amerique (Fr. W. I.).

Tree from 45 to 60 feet high and from 1 foot to 2 feet in diameter, very common along the southern coast of the island and distributed quite generally throughout tropical America. In Jamaica the wood is said to be used largely for staves of sugar hogsheads, and the best of the young shoots is used extensively for cordage.

Wood light or grayish-brown, rather fine and straight-grained, fissile, taking a fairly good polish, moderately soft, light, rather tough and durable in exposed situations. Pores small, solitary or in radial rows of from two to three. Pith rays narrow and inconspicuous.

XXXIII. Ternstroemiaceæ.

111. Represented in Porto Rico by three genera and five tree species, none of which are commercially important.

These are *Ternstroemia peduncularis* P. DC., from 20 to 30 feet high; *Ternstroemia heptasepala* Krug et Urb., from 15 to 25 feet high; *Ternstroemia luquillensis* Krug et Urb. (Palo colorado), from 30 to 60 feet high; *Cleyera albopunctata* (Griseb.) Krug et Urb. (Teta prieta), from 25 to 30 feet high; and *Haemocharis portoricensis* Krug et Urb. (Maricao, Niño de cota), from 15 to 60 feet high; all common in the Sierra de Luquillo, the second last extending through the Cordillera Central to Maricao.

XXXIV. Guttiferæ.

*112. *Mammea americana* L. Mamey, Mammea; Mammee apple (Br. W. I.).

Tree from 30 to 60 feet high and from 18 to 24 inches in diameter, common in all parts of the island. Its fruit is very highly regarded by the natives and it is very generally planted on this account here and elsewhere throughout the American Tropics. The tree also produces a medicinal gum. The wood is well adapted for house building, posts, and piles.

Wood reddish brown, beautiful, wavy, and fine-grained, taking a good polish, hard, heavy (61 pounds per cubic foot), resinous, and very durable in damp situations. Pores small, solitary, or occasionally in pairs, evenly distributed. Pith rays narrow, very inconspicuous.

*113. *Calophyllum calaba* Jacq. Marias, Palo de Maria; Santa Maria (Jamaica).

Tree from 45 to 60 feet high and from 2 to 3 feet in diameter (in Jamaica said to attain a height of 150 feet and a diameter of 5 feet and over), rather common in the humid north, east, and northwest sections and occasionally along the banks of the streams in the semiarid southcoast region. Common also throughout the West Indies. The wood is said to be greatly prized locally for carpentry work, and for canoes when the trunk is large enough. Elsewhere it has a variety of uses, such as construction work, shipbuilding and heavy machine work, posts, furniture, fellies of wheels, and shingles. Seeds yield an oil said to be used in lamps. Tree is suitable for ornamental planting.

Wood white or reddish in color, hard and durable. Reported to weigh about 46 pounds per cubic foot.

*114. *Clusia rosea* Jacq. Cupey, Palo de Cupey; Balsam Fig; Balsam tree (Br. W. I.).

Tree from 20 to 60 feet high and from 18 to 24 inches in diameter; commonly starts as a parasite on the branches of other trees, although it may start directly on the ground. It is quite generally distributed on the island and throughout the West Indies. The wood is used largely for posts and fuel.

Wood reddish-brown with brown and white streaks, very cross and fine grained, hard, heavy (55 pounds per cubic foot), and durable. Pores small, solitary or in pairs, evenly distributed. Pith rays moderately narrow, distinct, but not conspicuous.

NOTE.—Other incidental and unimportant trees in this and a closely related genus are *Clusia krugiana* Urb. (Cupey, Cupei, Cupeillo), occurring in the Luquillo region, and *Rheedia portoricensis* Urb. (=*Clusia acuminata* Spreng=*Tovomita elliptica* C. & C.) (Guayabacoa, Sebucán), growing along the seacoasts, shrubs or trees from 10 to 60 feet high, with wood resembling that of *Clusia rosea*.

XXXV. BIXACEÆ.

115. *Bixa orellana* L. Achiote, Achote, Bixa, Biji, Arnatta, Anatto.

Tree from 20 to 30 feet high and about a foot in diameter, occurring in the interior. It is planted in many parts of the island. The wood is little used. A coloring matter extracted from the arillus of the seed is much used locally for coloring rice, soup, etc.; and as the "anatto" of commerce is widely used for coloring cheese, chocolates, and butter, also by varnish makers for imparting a rich orange tinge to some grades of their products.

Wood nearly white in its natural state, but when polished turns slightly yellowish or reddish. On a radial surface it has narrow lines of slightly darker color, which correspond with the annual rings of growth clearly visible in transverse sections. It is very soft, light (about 25 pounds per cubic foot), weak, brittle, and not durable in contact with the soil. Pores rather conspicuous in the early wood, rendering it somewhat coarse and open-grained.

XXXVI. WINTERANACEÆ.

116. Represented by two genera, each with one tree species, neither one of which is of importance.

Winterana canella L. (Barbasco, Wild cinnamon), a tree from 25 to 45 feet high, of rather general distribution along the coast and throughout the West Indies, with a pale, orange-colored, aromatic bark which is used as a tonic; and *Pleodendron macranthum* (Baill.) v. Tiegh. (=*Cinnamodendron macranthum* Baill.) (Chupa gallo, Chupacallo), a tree from 20 to 30 feet high, from the Sierra de Luquillo, with a white, hard, and heavy wood.

XXXVII. FLACOURTIACEÆ.

117. *Homalium racemosum* Jacq. Tostado, Caracolillo, Cerezo.

Tree from 20 to 60 feet high, quite generally distributed throughout the island. The wood is very useful for building and carpentry.

Wood light-colored, fine-grained, moderately hard, heavy, and strong. Pores minute, numerous, isolated or in groups of two or three, evenly distributed. Pith rays numerous, minute, inconspicuous.

118. *Xylosma.*

Two species very similar as to their wood and uses and neither of any great importance are *Xylosma schwaneckeanum* Krug. & Urb. (=*Myroxylon schwaneckeanum* Krug. & Urb.) (Palo de candela, Palo colorado), and *Xylosma buxifolium* A. Gray (=*Myroxylon buxifolium* Krug. & Urb.) (Roseta), trees from 15 to 35 feet high and 1 foot in diameter, the former found chiefly in the Luquillo region and the latter throughout the southwestern part of the island and the West Indies generally. The wood has no uses except for fuel and charcoal.

Wood light brown, turning darker with age, straight and fine-grained, hard, heavy, strong, tough, and very durable in contact with the soil. Pores numerous, very small, arranged singly or in short radial rows. Pith rays very narrow and inconspicuous.

119. *Casearia.*

Five species attain tree size, namely, *Casearia guianensis* (Aubl.) Urb. (Cafeillo, Cafetillo, Palo blanco), from 15 to 30 feet high; *Casearia bicolor* Urb. (Talantrón, Cotorrerillo?), 45 feet high; *Casearia decandra* Jacq. (Caracolillo, Cereza, Cotorrerillo, Gia mansa, Palo blanco), from 18 to 25 feet; *Casearia arborea* (L. Cl. Rich.) Urb. (Gia verde, Rabojunco, Rabo ratón), from 15 to 45 feet high; and *Casearia sylvestris* Sw. (Cafeillo cimarron, Laurel espada, Sarna de perro), from 25 to 60 feet high.

These trees are most common in the calcareous foothills and along the coast in all parts of the island, except the last two, which are reported well distributed throughout the interior mountains from the Sierra de Luquillo to Maricao and Mayaguez. They are also widely distributed throughout the West Indies, except *C. bicolor*, which is reported only from Porto Rico (Utuado).

Wood of *C. guianensis* reported to be yellow, hard, and heavy (about 65 pounds per cubic foot), and to be used for lumber, for building native huts, for fences, and for similar uses.

XXXVIII. Cactaceæ.

120. Represented in Porto Rico by four genera (one exotic) and eight species (two exotic).

These have an erect form and attain tree proportions, or at least are designated "Pitajaya" (meaning tree-cactus) by the natives, although they do not all have a true woody structure and are consequently not real trees, namely, *Cereus quadricostatus* Bello (Pitajaya, Sebucán), from 6 to 30 feet high; *Cereus triangularis* (L.) Haw. (Pitajaya); *Cereus trigonus* Haw. (=*C. triangularis* Stahl. C. & C.) (Pitajaya), from 3 to 9 feet high; *Cereus peruvianus* (L.) Mill, a continental species from 15 to 25 feet high, occasionally cultivated in gardens; *Pilocereus royeni* (L.) Rümpl. (=*Cereus swartzii* Stahl. C. & C.) (Sebucán), 9 feet high; *Opuntia catacantha* Lk. et Otto, 15 feet high; *Opuntia guanicana* K. Schum. (Tuna), from 12 to 15 feet high; and *Nopalea coccinellifera* (L.) Salm-Dyck (Tuna de España, Tuna mansa), a tropical American and West Indian species 12 feet high, occasionally cultivated in gardens.

Their natural distribution is limited largely to the semiarid south coast region, including the small adjacent islands, as Culebra, etc., though they occasionally are found on the limestone hills along the north side of the island. All, except *C. quadricostatus* and *Opuntia guanicana*, which are strictly local in occurrence, are more or less common to the other islands of the West Indies and tropical America.

XXXIX. Thymelæaceæ.

121. *Daphnopsis.*

Two species attain tree size in Porto Rico: *Daphnopsis caribaea* Griseb. (Emajagua de sierra), from 15 to 45 feet high, found chiefly in the Sierra de Cayey and Cordillera Central and widely distributed throughout the West Indies; and *Daphnopsis philipiana* Krug et Urb. (Cieneguillo, Emajagua brava, Emajagua de sierra, Majagua quemadora), from 8 to 25 feet high, occurring throughout the mountains from the Sierra de Luquillo to the Cordillera Central.

XL. Rhizophoraceæ.

*122. *Rhizophora mangle* L. Mangle, Mangle colorado, Mangle sapatero, Red mangrove (Jamaica).

Tree from 30 to 50 feet high and from 1 foot to 3 feet through, growing in tidewater swamps. Wood used for making hogsheads and for knees and ribs of boats and other small craft, also for charcoal and fuel. The logs are used for posts and piling and occasionally cut into boards for flooring and interior finish.

Wood light red or reddish brown with darker, often nearly black, streaks, fine and cross grained, taking a good polish, very hard and heavy (about 70 pounds per cubic foot), strong and durable. Pores very small, numerous, isolated or in groups of two to five or more, evenly distributed. Pith rays visible to the unaided eye on a smooth transverse surface of the wood.

Note.—*Cassipourea*, a closely allied genera, is represented by a single species, *Cassipourea alba* Griseb. (Multa, Palo blanco de la costa, Palo de gongoli, Palo de hueso, Palo de oreja, Palo de toro), a shrub or small tree of from 15 to 30 feet high, with a rather general distribution in various parts of the central mountain area, as well as on the limestone foothills.

XLI. Combretaceæ.

*123. *Terminalia catappa* L. Almendra, Almendrón; Indian almond (Br. W. I.).

Tree from 30 to 60 feet high and about 2 feet in diameter. This is a species introduced from the East Indies, but naturalized and now a very common tree throughout the West Indies, especially in the lowlands. The wood is similar to mahogany and is used for furniture and house building.

Wood is brownish, coarse and straight grained, taking a beautiful polish, moderately hard and heavy (about 40 pounds per cubic foot), brittle and not strong. Pores of moderate size, evenly distributed, and connected by numerous tangential lines of soft tissue. Pith rays narrow and inconspicuous.

*124. *Buchenavia capitata* (Vahl:) Eichl. Granadillo; Yellow sanders (Br. W. I.).

Tree from 40 to 80 feet high and from 2 to 3 feet in diameter. This is a very common tree throughout the island. The wood is used for furniture and fancy carpentry work.

Wood fine and often wavy grained, satiny, taking a beautiful polish, moderately hard, heavy, strong, and tough. This wood has a very wavy grain. Pores moderately large, evenly distributed, solitary or sometimes in small groups. Pith rays narrow and inconspicuous.

*125. *Conocarpus erecta* L. Mangle, Mangle botón, Mangle botoncillo, Mangle colorado.

A shrub or small tree from 6 to 25 feet high, growing in the tidewater swamps. Wood used for making charcoal and for fuel.

*126. *Bucida buceras* L. Ucar, Ucar blanco, Hucar blanco, Bucaro; Wild olive wood of Jamaica; Bois grisgris (Haiti).

Tree from 30 to 60 feet high and about a foot in diameter. It is found chiefly near the coast. The wood is used for shelves in houses and for mallets, wooden cogs, and shingles. It was formerly used for knees in boat building.

Wood white or ashy brown, fine and cross grained, remotely resembling the wood of American elm. It is hard, heavy, strong, tough, and very durable in water. Pores very small, numerous, occurring solitary, and evenly distributed. Pith rays narrow but distinct.

127. *Laguncularia racemosa* (L.) Gaertn. Mangle blanco, Mangle bobo; White mangrove (Jamaica).

Tree from 20 to 30 feet high, growing in the tidewater swamps. Wood used for making charcoal.

XLII. Myrtaceæ.

*128. *Psidium guajava* L. Guayava, Guayaba, Guayava pera; Guava (Br. W. I.).

Tree from 15 to 25 feet in height and from 6 to 8 inches in diameter. It is cultivated throughout the island and in the Tropics generally and is well known on account of its fruit. The wood is used for making agricultural implements for structures where strength and elasticity are required, and for posts, fuel, and charcoal.

Wood brownish gray, tinged with red, compact, fine and straight grained, with a mottled and often very beautiful appearance. It is hard, heavy (about 45 pounds per cubic foot), strong, and tough. Pores very small, not numerous, and distributed in rather wide inconspicuous zones, visible only under the hand lens. Pith rays very inconspicuous.

*129. *Amomis caryophyllata* (Jacq.) Krug et Urb. Auzú, Ausú, Guayavita, Limoncillo, Malagueta, Pimienta malagueta; Bayberry tree, Bay rum tree, Wild cinnamon (Br. W. I.).

Tree from 20 to 45 feet high and about 2 feet in diameter, occurring in mountainous parts of the island and throughout the West Indies. The wood is suitable for carpentry, cabinetwork, posts, sills, cogs, rollers, and other millwork, and was formerly exported. The leaves have the taste and odor of lemon, and an essential oil of bay or bay oil is obtained by distillation.

Wood dark, mottled, compact, fine and occasionally cross grained, taking a beautiful polish. It is very hard, heavy (about 60 pounds per cubic foot), strong, tough, and very durable. Pores very small, numerous, evenly distributed throughout the wood. Pith rays very narrow and inconspicuous.

*Note.—A variety of this species is also recognized, *Amomis caryophyllata* var. *grisea* (Kiaersk.) Krug et Urb. (Limoncillo, Malagueta, Pimienta), a tree sometimes 50 feet high in mountainous regions, the wood of which is very similar to that of the preceding.

130. *Myrcia.*

The genus is represented in Porto Rico by the following four species, which attain tree size: *Myrcia leptoclada* P. DC. (Guayabacón, Guayavacón); *Myrcia splendens* (Sw.) P. DC. (Rama menuda, Hoja menuda); *Myrcia? pagani* Krug et Urb. (Ausú); and *Myrcia deflexa* (Poir.) P. DC. (Cieneguillo, Guayavacon).

Trees from 15 to 60 feet high, found in the mountainous regions of the island. The wood is used very little except for fuel and charcoal. Wood reddish brown, hard, heavy, and strong.

131. *Calyptranthes sintenisii* Kiaersk. Hoja menuda, Limoncillo, Limoncillo de monte.

Tree from 15 to 25 feet high and from 6 to 10 inches in diameter, occurring in the Luquillo region. The wood is used in carpentry and for fuel and charcoal.

Wood fine and straight grained, hard, heavy, strong, and flexible. Pores small and numerous. Pith rays inconspicuous.

132. *Eugenia aeruginea* P. DC. Guasávera, Guayabacón.

Tree from 30 to 60 feet high and from 1 foot to 2 feet in diameter, rather widely distributed on the island.

Wood light brown or chestnut colored, fine and straight grained, beautiful when polished, hard, heavy, strong, and flexible. Pores very small and arranged singly or in radial rows of from two to three between the very narrow inconspicuous pith rays.

Note.—Other species of this genus very similar to the above but of slight importance are *Eugenia stahlii* (Kiaersk.) Krug et Urb. (Guayabota, Limoncillo), tree from 15 to 60 feet high and from 1 to 2 feet in diameter; *Eugenia sintenisii* (Kiaersk.) Krug et Urb., from 45 to 60 feet high; and *Eugenia floribunda* West (Murta) 30 feet high. All are common throughout the island and their woods are similar to the preceding.

*133. *Eugenia jambos* L. (=*Jambosa jambos* Millsp.). Poma rosa; Rose apple (Br. W. I.).

Tree from 20 to 50 feet high and from 1 to 2 feet in diameter, introduced from the East Indies and now largely naturalized throughout the island. The wood is used for barrel hoops, poles, fuel, and charcoal. It also furnishes material from which large baskets are made.

Wood grayish brown, fine and straight grained, hard, heavy, strong, and tough. Pores small and arranged in irregular tangential lines. Pith rays very narrow and scarcely visible under the hand lens.

XLIII. Melastomataceæ.

134. *Miconia tetrandra* (Sw.) D. Don. Camasey.

Tree from 30 to 50 feet high and about a foot in diameter, common in the mountains of Porto Rico and found on all the islands of the West Indies. The wood is used for poles, fuel, and charcoal.

Wood light brown, fine and straight grained, hard, moderately heavy, strong, flexible, and durable in the soil. Pores small, numerous, and evenly distributed. Pith rays very narrow and inconspicuous.

Note 1.—Three other species in this genus similar in size, distribution, and uses are *Miconia guianensis* (Aubl.) Cogn. (Camasey, Camasey blanco, Camasey de costilla); *Miconia impetiolaris* (Sw.) D. Don (Camasey, Camasey de costilla) and *Miconia prasina* (Sw.) P. DC. (Camasey).

Note 2.—Three other genera and six species in this family attain tree size, though they are of but slight local or general importance, namely, *Calycogonium squamulosum* Cogn. (Granadilla cimarrona), from 15 to 30 feet high, from the Sierra de Luquillo; *Calycogonium biflorum* Cogn., from 25 to 30 feet high, from near Barranquitas; *Heterotrichum cymosum* (Wendl.) Urb. (Camasey colorado, Camasey de paloma, Terciopelo), from 25 to 30 feet high, from various parts of the island; *Henriettella macfadyenii* (Triana), 60 feet high, from Sierra de Luquillo and Cordillera Central, found also in Jamaica; *Henriettella membranifolia* Cogn., 30 feet high, from Lares; and *Henriettella fascicularis* (Sw.) Ch. Wright (Camasey de oro, Camasey de paloma), from 25 to 30 feet high, from various places on the island, also throughout the Greater Antilles.

XLIV. Araliaceæ.

135. *Gilibertia arborea* (L.) E. March (=*Aralia arborea* L.). Muñeca, Palo cachumba, Pana, Vibona.

Tree from 30 to 60 feet high, quite common throughout the island, and found in all parts of the West Indies. The wood resembles boxwood (*Buxus sempervirens* L.) and should make a suitable substitute.

Wood light or pale yellow, very fine grained, taking a good polish, very hard, heavy, strong, and tough. Pores very small, numerous, scarcely visible under the hand lens, and evenly distributed. Pith rays very narrow and inconspicuous.

Note.—Another species in every way similar to the above is *Gilibertia laurifolia* E. March (Palo cachumba, Palo de gangulin, Palo de vaca, Vibona).

*136. *Didymopanax morototoni* (Aubl.) Dcne et Pl. Yagrume macho, Yagrume; Grayume, Grayume macho, Grayumo, Pana cimarrona, Llagrume, Llagrume macho.

Tree from 40 to 60 feet high and about a foot in diameter, very common in the mountains and distributed quite generally throughout tropical America. The wood is used for boards and beams in house building, and has been suggested as a good material for making matches.

Wood light olive brown, fine and straight grained, moderately hard, heavy, brittle, and not strong. Pores small, very numerous, and more or less evenly distributed throughout the annual rings of growth, which can be readily distinguished by means of the hand lens. Pith rays very conspicuous.

XLV. Myrsinaceæ.

137. *Ardisia glauciflora* Urb. Mameyuelo.

Tree from 15 to 25 feet high, occurring in the Luquillo region. The wood is used for furniture.

Wood white, beautifully marked with fine lines, fine-grained, taking a good polish, hard, and heavy. Pores minute, isolated or in groups of two or three, evenly distributed. Pith rays numerous, broad, very conspicuous.

Note.—Another species, *Ardisia guadalupensis* Duchass. (Badula, Mameyuelo), attains a somewhat larger size and wider distribution on the island. Its wood is similarly used and has the same structural characteristics as the above but is a light reddish brown instead of white.

XLVI. Sapotaceæ.

***138.** *Achras zapota* L. Sapodilla, Níspero[1]; Naceberry, Bullet tree (Br. W. I.).

Tree from 30 to 45 feet high and about a foot in diameter. It is cultivated and wild on the island, having been originally introduced from Venezuela, and widely planted for the sake of its fruit. It is said to yield a gum similar to "gum chicle," principally obtained from *Mimusops globosa* and *Sapota zapotilla*. The wood is adapted for inside work, cabinetmaking, and furniture.

Wood light red with darker stripes, fine and straight grained, susceptible of a high polish, difficult to work on account of its extreme hardness, heavy (about 74 pounds per cubic foot), strong, tough, and very durable in contact with the soil. Pores very small, numerous, and arranged in more or less distinct radial rows between the narrow pith rays.

Note.—[illegible] he above is *Calocarpum mammosum* (L.) Pierre (Mamey Sapote; Bartaballi, [Br. Guiana]), a tree from 30 to 40 feet high and of limited occurrence on the island.

139. *Lucuma multiflora* A. DC. Acana, Hacána, Jácana; Contrevent (Br. W. I.).

Tree from 40 to 90 feet high and from 2 to 3 feet in diameter, found quite generally on the island and throughout tropical America. It yields very excellent timber which is used for mill rollers, frames, furniture, and house building.

Wood light colored, fine and straight grained, beautiful when polished, hard, very heavy, strong, tough, and durable. Pores small and arranged in radial rows. Pith rays narrow and indistinct.

140. *Micropholis.*

There are three tree species in this genus, *Micropholis garcinifolia* Pierre (Caimitillo), from 45 to 60 feet high; *Micropholis curvata* (Pierre) Urb. (Leche prieto), from 30 to 60 feet high; and *Micropholis chrysophylloides* Pierre (Caimitillo, Leche prieto), from 60 to 75 feet high, the former in the Sierra de Luquillo chiefly and the others in the Sierra de Cayey and Cordillera Central. The wood, particularly of the last named, is very hard and heavy, similar to that of *Achras Zapota* and is regarded locally as a first-class wood.

***141.** *Sideroxylon fœtidissimum* Jacq. (=*S. mastichodendron* Jacq.). Ausubo,[2] Tortuga, Tortugo amarillo, Tortugo prieto; Caguani (Cuba); Mastic (Fla.).

Tree from 30 to more than 50 feet high and from 2 to 3 feet in diameter, occurring on the coast. It is common in southern Florida and throughout tropical America

[1] This should not be confused with the true medlar, *Mespilus germanica* L., to which the Spanish "níspero" most commonly applies, nor with the Japanese medlar or loquat (*Eriobotrya japonica* Lindl.), neither of which are known to the Porto Rican public (C. & C.).

[2] Two species, *Sideroxylon fœtidissimum* and *Mimusops nitida* are both known as "ausubo." Of the former Gifford and Barrett say, that it is "probably the most valuable wood per cubic foot in Porto Rico." although they admit that "possibly two species are included under this name," which is more likely. According to Urban, *Sideroxylon fœtidissimum* is not reported from the Sierra de Luquillo or other parts of the interior, while *Mimusops nitida* is. Acocrding to Fernow and Taylor, however, this *Sideroxylon* is widely distributed in the Sierra Maestra (Cuba).

and the West Indies, ranking as a very valuable timber. The wood is used locally for all purposes requiring great strength and durability, such as beams and rafters, also for all parts of wheels, axles and other parts of native bull carts, for ox yokes and other native uses, and somewhat for furniture.

Wood maroon-red, very fine and straight grained, susceptible of a good polish, easily worked considering its hardness, and very durable in the Tropics; in the temperate climate it is less durable. Wood hard, heavy (about 65 pounds per cubic foot), strong, and tough. Moderately conspicuous ducts in short detached long and short chains (single lines of cells) evenly diffused; chains usually between two medullary rays. Medullary rays very numerous, minute, indistinct. Wood fibers slightly interlaced and appearing straight-grained. Resembles somewhat a fine-grained teak. (Hill and Sudworth.)

NOTE.—Another species of very limited distribution is *Sideroxylon portoricense* Urb. (Tabloncillo), a tree from 75 to 90 feet high, reported only from the vicinity of Utuado and Lares. Wood similar to that of *Sideroxylon fœtidissimum*, and probably similarly used.

***142.** *Dipholis salicifolia* (L.) A. DC. Almendrón, Tabloncillo.

Tree from 30 to 40 feet high and from 12 to 18 inches in diameter, occurring in dry limestone soils near the coast. It is common in southern Florida and throughout the West Indies. The wood is used locally principally for fuel and charcoal.

Wood dark brown-red, fine and straight grained, taking a beautiful polish, hard, heavy (about 55 pounds per cubic foot), strong, and tough.

NOTE.—Another rather incidental species is *Dipholis sintenisiana* Pierre (Espejuelo), a tree from 60 to 70 feet high, from the northwestern part of the island, having a wood similar to that of *D. salicifolia*.

***143.** *Chrysophyllum cainito* L. Cainito, Caimito [illegible] Star apple (Br. W. I.).

Tree from 45 to 60 feet high and from 12 to 18 inches in diameter. It is a cultivated and wild tree and found in most parts of the island. The wood is suited to a variety of uses and particularly in exposed situations.

Wood red or reddish-brown, very fine and curly grained, taking an excellent polish, hard, heavy, strong, tough, and very durable in contact with the soil. Pores very small and arranged in short radial rows between the rather inconspicuous pith rays.

***144.** *Chrysophyllum oliviforme* L. Teta de burra, Lechesillo.

Tree from 30 to 40 feet high and about a foot in diameter from the southwestern part of the island. It is distributed throughout the West Indies and southern Florida, but is nowhere common.

Wood light brown tinged with red, fine and straight grained, taking a good polish hard, heavy (about 58 pounds per cubic foot), very strong, and tough. Pores small and arranged in short radial rows, which are easily seen on a smooth transverse surface under a hand lens.

NOTE.—Other species of this genus are *Chrysophyllum bicolor* Poir. (Caimitillo, Lechesillo), from 30 to 50 feet high, occurring very locally and in Porto Rico only; *Chrysophyllum argenteum* Jacq. (Caimito verde, Lechesillo), from 25 to 60 feet high, occurring rather widely distributed throughout the island and others of the West Indies, and *Chrysophyllum pauciflorum* Lam. (Caimito de perro), from 40 to 60 feet high, reported only from the southern part of the island. Wood of each is similar to that of the above.

145. *Mimusops.*

Two species of this genus occur in Porto Rico, *Mimusops nitida* (Sessé et Moc.) Urb. (Acana, Ausubo [1]), a tree from 20 to 50 feet or more high, occurring in mountainous regions; and *Mimusops duplicata* (Sessé et Moc.) Urb. (= *M. globosa* Griseb.) (Mameyuelo, Sapote, Sapote de costa, Zipote, Balata), from 40 to 60 feet high, occurring along the north coast. Both are local species.

[1] See footnote under *Sideroxylon fœtidissimum*.

Wood of these two species is dark brown, fine and straight grained, taking a splendid polish, hard, heavy (about 60 pounds per cubic foot), strong, tough, and very durable in contact with soil and water. Pores very small, and arranged in more or less oblique radial rows which are visible under the hand lens.

XLVII. Ebenaceæ.

146. *Maba sintenisii* Krug. et Urb. Guayabota-nispero, Tabeiba.

Tree from 25 to 30 feet high, of uncommon occurrence, reported from only two localities on the island.

Wood very light brown, very fine and straight grained, taking a very good polish, very hard, heavy, strong, tough, and durable. Pores very minute, numerous, and arranged in indistinct radial rows. Very fine tangential lines of soft tissue are visible under a strong hand lens.

***147.** *Diospyros ebenaster* Retz. Guayabota; Zapote negro ó prieto (Mexico).

Tree about 30 feet high, of infrequent occurrence in the mountains. It is native of the West Indies, Mexico, and Malay Islands. It has a black bark and heartwood. This tree attains much larger size in Mexico than it does in Porto Rico, where it is used only for fuel and charcoal.

XLVIII. Symplocaceæ.

148. *Symplocos.*

Genus represented in Porto Rico by five tree species, namely, *Symplocos lanata* Krug et Urb. (Palo de nispero cimarron), from 24 to 30 feet high, from Adjuntas and Peñuelas; *Symplocos micrantha* Krug et Urb. (Palo de cabra), from 20 to 50 feet high, from the Sierra de Luquillo and Cordillera Central; *Symplocos martinicensis* Jacq. (Aceituna, Aceituna blanca, Aceituna cimarrona), from 10 to 30 feet high, from Bayamon and Añasco; *Symplocos polyantha* Krug et Urb. (Palo de cabra), from the Sierra de Luquillo; and *Symplocos latifolia* Krug et Urb. (Aceituna), from 25 to 45 feet high, from Sierra de Cayey and Cordillera Central. Except for the third of these, which occurs generally throughout the West Indies, all are local species. Their woods, which are alike, are apparently very little used.

The wood of *S. martinicensis* is white, hard, moderately heavy, and strong. Pores small, numerous, isolated or in groups of two to four, evenly distributed. Pith rays narrow, inconspicuous.

XLIX. Styracaceæ.

149. *Styrax portoricensis* Krug and Urb.

Tree apparently little known even locally. Reported as being from 30 to 60 feet high and occurring only in the mountain forests of the eastern part of the island.

L. Oleaceæ.

150. *Linociera domingensis* (Lam.) Knobl. (= *Mayepea domingensis* Krug and Urb.). Hueso blanco, Palo de hueso, Huesillo, Palo blanco.

Tree from 30 to 45 feet high, quite generally distributed throughout the northern part of the island. Common also to the other islands of the Greater Antilles.

Wood light colored, moderately fine grained, hard, and moderately heavy. Pores small, isolated or in groups of from two or three, evenly distributed. Pith rays narrow, inconspicuous.

LI. Apocynaceæ.

151. *Plumiera alba* L. Alelí, Alelí cimarron, Tabeiba; Frangipanic blanc, Bois de lait (Fr. W. I.).

Tree from 20 to 30 feet high and from 6 to 10 inches in diameter, occurring along the coast, very common throughout tropical America. The wood is used for carpentry work, and as a substitute for true sandalwood (*Santalum album* L.).

Wood yellowish-white or light grayish-yellow, marked with numerous irregular undulating lines, giving the wood a very pleasing appearance. It is very compact and fine grained, taking a very good polish, hard, heavy, strong, and tough.

152. *Rauwolfia nitida* Jacq. Cachimbo, Palo amargo, Palo de muñeco.

Tree from 30 to 60 feet high, common to the sandy coast soils. Common also to other of the West Indies.

LII. Borraginaceæ.

153. *Cordia alliodora* (R. & P.) Cham. (=*C. gerascanthus* Jacq. and *C. gerascanthoides* C. & C.) Capá, Capá prieta; Prince wood, Spanish elm (Jamaica).

Tree from 30 to 60 feet high and from 12 to 18 inches in diameter, found commonly in the mountainous interior. Although now rather scarce, this wood is very highly prized locally because of a variety of good qualities. In Jamaica it is considered one of their best woods. It is used for furniture, flooring, doors, venetian blinds, beds, interior finish, carriage building, posts, and cooperage.

Wood rich light brown with dark streaks, fine grained, taking a good polish, moderately hard and heavy (about 36 pounds per cubic foot), strong and durable. Pores small, numerous, isolated or in groups of from two or three, evenly distributed. Annual rings of growth visible on a smooth transverse surface. Pith rays narrow but conspicuous, visible to the unaided eye on a smooth transverse surface.

Note.—Other species of this genus are *Cordia sebestena* L. (Vomitel colorado, San Bartolomé; Aloe wood [Br. W. I.]; Geiger tree [Florida Keys]), from 20 to 35 feet high, occurring along the eastern, southern, and western coasts. It is often planted as an ornamental tree in tropical gardens. Wood brown, fine grained, moderately hard, and heavy. *Cordia collococca* L. (Cereza cimarrona, Palo de muñeca; Clammy cherry [Jamaica]), from 15 to 30 feet high, occurring in the southwestern part of the island near the coast. Used for barrel staves in Jamaica, having a wood which is soft, brittle, and not durable. *Cordia nitida* Vahl. (Cerezas, Cereza cimarrona, Muñeca), from 15 to 60 feet high, occurring in the southern part of the island. *Cordia sulcata* DC. (Moral, Moral de paz), from 30 to 60 feet high, found in the interior mountain forests. Wood little used. **Cordia borinquensis* Urb. (Muñeca, Palo de muñeca, Capá cimarron), from 20 to 60 feet high, found in interior mountain forests, having wood light yellow, fine grained, taking a good polish, moderately heavy, and hard.

LIII. Verbenaceæ.

154. *Citharexylum fruticosum* L. (=*Citharexylum quadrangulare* Griseb.). Péndola; Péndula, Pendula colorado, Palo de guitarra, Balsamo, Higuerillo.

Tree from 20 to 40 feet high and from 12 to 20 inches in diameter, occurring near the eastern and southern coasts. It is used for furniture and in house building. The natives make their guitars from it.

Wood light red, moderately fine-grained, fairly hard, heavy (about 46 pounds per cubic foot), and strong.

Note.—Incidental species in this and a closely allied genera are *Citharexylum caudatum* L. (Higuerillo), from 15 to 60 feet high, from the Sierra de Luquillo and Cordillera Central, also occurs in the other of the Greater Antilles, the Bahamas, and Mexico: and *Callicarpa ampla* Schauer (Capá rosa, Péndola cimarron), from 25 to 50 feet high, occurring only in mountainous regions of Porto Rico.

***155.** *Petitia domingensis* Jacq. Capá, Capá blanca, Capá sabanero, Capá de sabána, Capá amarillo, Palo de capá de sabána; Fiddle wood (Br. W. I.).

Tree from 20 to 50 feet high and 2 feet or more in diameter, occurring chiefly in the interior. Common also to the other islands of the Greater Antilles. The wood is used locally for making rollers in coffee-hulling mills and is suitable for cabinetwork, interior finish, and general building purposes where a hard, tough wood is required.

Wood light to dark brown, streaked with a decidedly beautiful wavy grain, moderately fine grained, taking a good polish, hard, and heavy. Pores small, isolated, or in groups of two or three, evenly distributed. Pith rays minute, inconspicuous. Structurally similar on the radial section to the American beech.

156. *Vitex divaricata* Sw. Higuerillo, Péndula, Palo de péndula, Péndula blanco; Lizard wood, Fiddle wood (Br. W. I.).

Tree from 30 to 60 feet high and from 20 to 30 inches in diameter, found in mountainous regions, common to many of the islands of the Lesser Antilles. Used locally for shelves, boards, framework of houses, in cabinetwork, and suitable for all inside and outside work.

Wood white, moderately fine grained, hard, heavy (about 50 pounds per cubic foot), strong, and durable. Pores small, isolated or in groups of from two to five. Pith rays narrow, inconspicuous.

***157.** *Avicennia nitida* Jacq. Chifle de vaca, Mangle blanco, Mangle bobo; Black mangrove (Br. W. I.).

Shrub or tree from 40 to 70 feet high and from 12 to 24 inches in diameter, found in tidal swamps. Widely distributed throughout the West Indies, and the shores of the American and African continental Tropics. The wood is used locally for foundations, underpinning for houses, fence posts, drains, and for charcoal and fuel.

Wood dark brown, rather coarse grained, with conspicuous tangential lines visible on a transverse surface, hard, heavy, and very durable in damp situations. Pores small, isolated or in groups of from two to five, arranged largely in radial lines. Pith rays narrow, inconspicuous.

LIV. Bignoniaceæ.

158. *Tabebuia.*

This genus embraces two local species, first described by Urban in 1899, of very limited distribution, namely, *Tabebuia rigida* Urb. (Roble), from 20 to 60 feet high from the Luquillo region, and *Tabebuia schumanniana* Urb. (Roble colorado), from 30 to 50 feet high, occurring in the mountains near Utuado.

Wood light brown, fine grained, taking a good polish, moderately hard and heavy, strong, tough, and very durable. Pores small, numerous, arranged in conspicuous tangential lines visible to the unaided eye on a smooth transverse surface. Pith rays inconspicuous.

***159.** *Tecoma pentaphylla* (L.) Juss. Roble, Roble blanco; West Indian boxwood.

Tree from 20 to 60 feet high, quite common throughout the island, particularly in the limestone hills, and found in the Antilles generally. The wood is used in Porto Rico and throughout tropical America for ox yokes, piles, for house and boat building, and for general purposes.

Wood white and fine grained, moderately hard, heavy (about 52 pounds per cubic foot), and strong. Pores small, isolated or in groups of two or three, evenly distributed. Faint tangential lines of soft tissue may be seen with a hand lens. Pith rays minute, inconspicuous.

160. *Tecoma leuycoxylon* (L.) Mart. Roble, Roble prieto; White wood (Br. W. I.).

Tree from 20 to 60 feet high most commonly found in the limestone hills of the south coast and less frequently in the Sierra de Luquillo and Cordillera Central. Not an important tree in Porto Rico, but in other parts of tropical America it yields a wood used for furniture, house building and sounding boards, and musical instruments, also for posts, piles, and other purposes in exposed situations.

Wood resembles somewhat that of the preceding.

Note.—Another species of little importance is *Tecoma haemantha* (Bertero) Griseb. (Roble), from 25 to 30 feet high, from the coast hills and interior valleys.

***161.** *Crescentia cujete* L. Higüero; Calabash (Br. W. I.); Jícara, Tigulate, Temante, Palo de melon, Melon tree (Mexico and Central America).

Wild and cultivated tree from 10 to 45 feet high and from 12 to 18 inches in diameter, widely distributed throughout the island. The wood is not known to be used locally, but the rind or bony outside covering of the fruit, like the shell of the coconut, finds a multiplicity of domestic uses for cooking utensils and tableware. The wood is used

in Jamaica for tool handles, carriage parts, fellies of wheels, saddles, and chairs. It is also employed for ship's knees and cabinetwork in Mexico and Central America.

Wood light brown, coarse grained, taking a good polish, moderately hard, heavy (about 54 pounds per cubic foot), very tough, flexible, and durable in the ground. Pores small, isolated or in groups of two or three, evenly distributed. Alternating tangential wavy lines of hard and soft tissue are barely visible to the unaided eye on a smoothly cut tranverse surface. Pith rays narrow, inconspicuous.

LV. RUBIACEÆ.

162. *Rondeletia portoricensis* Krug & Urb.

A recently described tree from 20 to 60 feet high and from 12 to 20 inches in diameter, occurring in various places in the Sierra de Luquillo and Cordillera Central.

***163.** *Randia aculeata* L. Tintillo, Palo de espinillo, Palo de cotorra, Cambrón, Escambrón; Ink berry (Br. W. I.).

Tree from 20 to 30 feet high and from 6 to 9 inches in diameter, widely distributed throughuot the island. Wood little used.

Wood dark brown, fine, close and straight grained, taking a very good polish, hard, heavy, strong, tough, and very durable. It resembles the true lignum-vitæ in general appearance. Pores exceedingly small and indistinct. Pith rays very narrow and scarcely visible under the hand lens.

***164.** *Genipa americana* L. Jagua, Hagua.

Tree from 30 to 60 feet high and from 15 to 20 inches in diameter, widely distributed throughout the island and the West Indies generally. The wood is suitable for packing boxes, shoe lasts, barrel hoops, and wherever strength and elasticity are required.

Wood light brown, tinged with red, very fine grained, moderately hard, heavy (about 54 pounds per cubic foot), strong, tough, and durable; in these qualities it resembles the ash. Pores small, isolated, or occasionally in pairs, evenly distributed. Pith rays numerous, narrow, inconspicuous.

165. *Guettarda scabra* (L.) Lam. Palo de cucubano, Serrasuela.

Tree from 20 to 40 feet high and from 8 to 12 inches in diameter, occurring in the coast hills chiefly, and sparingly in the interior valleys. The wood is used principally in building native huts.

Wood ash-colored, moderately fine grained, rather hard and heavy (about 54 pounds per cubic foot). Pores small, isolated or in groups of from two to five or more, and evenly distributed. Pith rays small, inconspicuous.

NOTE.—Other less important species with very limited distribution and wood similar to the above are *G. krugii* Urb., *G. ovalifolia* Urb., and *G. lævis* Urb., which attain a height of from 30 to 60 feet and occur chiefly in the coast hills and shore woodlands.

166. *Antirrhœa obtusifolia* Urb. Tortuguillo.

Tree from 25 to 45 feet high, found in the mountains of the Luquillo region and Yabucoa. The wood is apparently little used, although suitable for structural and cabinet work.

Wood light reddish-brown, straight and fine grained, taking a good polish, hard, heavy, and strong. Pores minute, evenly distributed throughout the annual rings of growth, which are easily visible to the unaided eye.

167. *Antirrhœa coriacea* (Vahl.) Urb. Quina, Palo de quina, Boje, Boje quina.

Tree from 40 to 50 feet high and sometimes 2 feet in diameter, chiefly occurring in the northern part of the island. Occurs also in several of the islands of the Lesser Antilles. The wood is used for carpentry work, furniture, cabinetwork, and framework of houses.

Wood yellowish, very fine and straight grained, taking a very good polish, hard, heavy, strong, though brittle, and very durable in contact with the soil.

NOTE 1.—*Antirrhœa sintenisii* Urb. (Quina) is a tree sometimes 45 feet high, described from the limestone hills in the vicinity of Utuado, Lares, and Manati, and yielding yellowish wood similar to that of *Antirrhœa coriacea*.

NOTE 2.—*Chione*, a closely related genus, is represented by one species of little known importance. *Chione venosa* (Sw.) Urb. (Martin avila, Palo blanco, Santa olalla), a tree from 20 to 50 feet high reported from the Sierra de Luquillo, Sierra de Lares, and the vicinity of Bayamon and Toa-Alta. Found also in several other of the West Indies. Wood is said to be made into lumber.

***168.** *Coffea arabica* L. Café, Café macho; Coffee (Br. W. I.).

A cultivated and seminaturalized tree from 10 to 20 feet high and from 2 to 4 inches in diameter, grown in plantations at all elevations but doing best in sheltered locations at or above 2,500 feet on the northern and western parts of the island. Native of Arabia. Coffee is one of the most important articles of export of Porto Rico. The wood is often used for walking sticks.

Wood white, very fine grained, taking a fine polish, hard, heavy, strong, and tough. Pores minute, very numerous and evenly distributed. Pith rays minute and inconspicuous.

***169.** *Ixora ferrea* (Jacq.) Benth. Palo de hierro, Dajao, Palo de dajao, Hackia; West Indian or Martinique ironwood (Br. W. I.).

Tree from 15 to 30 feet high, occurring quite generally in the limestone hills and somewhat on the slopes of the interior mountains. Elsewhere in the West Indies and in the northern part of South America it sometimes attains a height of from 30 to 60 feet and a diameter of from 1 foot to 2 feet. The wood is not reported as being used locally, but in the other countries where it occurs it is used largely for cogs, shafts, and furniture.

Wood dark brown, taking a very beautiful polish, exceedingly hard, heavy, very strong, and tough.

170. Other genera of this family represented by tree species.

Psychotria brachiata Sw. (Palo de cichimbo), usually a shrub or small tree, but occasionally 45 feet high; *Palicourea alpina* (Sw.) DC., shrub or small tree from 15 to 30 feet high; and *Faramea occidentalis* (L.) A. Rich (Cafeillo, Palo de toro), from 15 to 45 feet high, all rather widely distributed locally as well as generally throughout the West Indies.

LVI. CAPRIFOLIACEÆ.

171. *Sambucus intermedia* var. *insularis* Schwerin. Saúco.

A cultivated and seminaturalized tree occurring in various places throughout the island. Introduced from Central America and found in many of the other West Indian Islands.

LVII. GRAMINEÆ.

172. *Bambusa vulgaris* Schrad. Bambú; Bamboo.

This bamboo (although the bamboos belong to the grass family and are not trees at all) has an erect wood stem which attains a height of 40 feet and a diameter of 4 inches, and is rather commonly distributed over the island, particularly along the watercourses and throughout the West Indies. It is a native of Java. The bamboos, of which there are many species, are adapted to a wide variety of uses and their planting should be greatly extended in Porto Rico.

APPENDIX II.

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